

cinefex

number 8
\$3.95



cinefex

...the journal of cinematic illusions

editor & publisher
Don Shay

contributing editors
Paul Mandell
Jordan Fox

circulation manager
JoDyne Shay

editorial consultant
Robert P. Everett

editorial services
Ann Dredla

CINEFEX 8 — April 1982. Published quarterly at P.O. Box 20027, Riverside, California 92516. Subscription rates (U.S. only): four issues — \$12; ten issues — \$25. Return postage must accompany all unsolicited manuscripts, photos or other materials. Printed by R.B. Graphics, Riverside, California; typesetting by The Set-Up, Riverside, California; color separations by Vivicolour, Covina, California. Contents copyright © 1982 by Don Shay. All rights reserved. Reproduction in whole or in part without permission is prohibited.

Tronic Imagery.....4

Tron signals the emergence of the Walt Disney organization from the black hole of formula filmmaking which has characterized the studio since the death of its founder. Combining state-of-the-art computer generated imagery with dazzling animation-enhanced live-action, the film creates an energy-charged parallel world of video games and electronic beings. Writer-director Steven Lisberger explains his concept for the film and traces the steps involved in seeing it through to fruition, while effects co-supervisors Richard Taylor and Harrison Ellenshaw reveal the technical aspects of the filmic innovations employed. Providing additional details are conceptual artist Syd Mead, technical effects supervisor John Scheele, animation effects chief Lee Dyer, and nearly a dozen other technicians and artists. *Article by Peter Sørensen.*

Silent Running.....36

A rare journey into the humanistic side of science fiction, *Silent Running* was pieced together a decade ago by Douglas Trumbull and a team of dedicated technicians and designers, many of whom have since risen to prominence in the field of special effects. Trumbull details the evolution of the project and his involvement as writer-director and effects supervisor. Effects co-supervisors John Dykstra and Richard Yurich explain the varied techniques involved in filming the space freighter *Valley Forge*. In addition, the transformation of a Navy aircraft carrier into a spaceship interior, the design and construction of the unique drone robots and mini-cars, and a variety of other production details are discussed at length by art director Wayne Smith, drone coordinators James Dow and Don Trumbull, and special designers Bill Shourt and Richard Alexander. *Article by Pamela Duncan.*

FRONT COVER — *Tron* pilots his speeding light-cycle in *Tron*.
The space freighter *Valley Forge* from *Silent Running* — BACK COVER.

TRONIC IMAGERY

article by
Peter Sørensen

“It will remind you of something you have never seen before!” is what everyone working on *Tron* says with a mischievous twinkle in the eye. Obviously, the statement is an in-joke of sorts. But in spite of the fact that it seems to describe an impossibility, there is some truth to it. The visual pyrotechnics in *Tron* have been used only briefly before in features — spectacular effects developed by the same visual physicists whose laboratory has been that of contemporary television commercial design and production. Thanks to them, every person in the world with access to a television set is a connoisseur of sophisticated motion graphics techniques. But before *Tron*, only scant examples of these techniques had found their way into the cinema.



With the current rage in video games and home computers, *Tron* is a timely fantasy. Inspired and guided by writer-director Steven Lisberger, the plot revolves around the premise that a separate universe exists in the software of computers which is parallel to our own space-time. The story concerns the life-and-death adventures of a master programmer and video game champ named Flynn (Jeff Bridges), who gets transferred into that alien electronic world and must discover a way out. The software environment is populated by entities that are the alter egos of “users” in the real world, including Alan Bradley (Bruce Box-leitner) whose program’s name is TRON — mightiest of the electronic warriors — and the unscrupulous Dillinger (David Warner), whose surrogate is the evil Sark. The software characters are all aglow with electricity that courses through the patterns of circuitry on their costumes. They drive or fly many kinds of vehicles which have also been programmed into the computer — some of which were originally intended for video game use, such as speeding light-cycles, battle tanks, and flying antigravity Recognizers.

Flynn puts these all to good use at various times as he is pursued and hunted by the enemy. Eventually, Flynn and *Tron* take a solar sailer, flying on a beam of light, with the ever-nasty Sark close on their heels in his gigantic, levitating aircraft carrier. Their goal is to get to the Master Control Program — or MCP — the ultimate villain in the film, in order to make it release Flynn back into the real world.

For the special effects industry, *Tron* is a double-barreled breakthrough in that it makes use of two very exciting new tools for the special effects kit — computer generated imagery and back-lit, enhanced live-action. Because of this, there seems little doubt that *Tron* is destined to take a prominent place in the Hollywood history books, marking the beginning of a new era, particularly with respect to its computer generated imagery — or CGI. No doubt, later on in this decade we will look back on the achievements of *Tron*’s electronic imagery as primitive, pioneering efforts. But while these new imaging techniques are in some ways rough around the edges, they are the kinds

of pioneering breakthroughs that open up new worlds, and against which subsequent efforts are measured.

“I think,” said Harrison Ellenshaw, “that *Tron* will do for the computer graphics industry what *Star Wars* did for motion control.” Ellenshaw is the associate producer on the picture and co-supervisor of special effects. “The number one thing that appealed to me coming on the film is that it’s an original, and it’s unique, and it’s not a copy. Four out of five films in Hollywood are copies of something else.” Supervisor of effects Richard W. Taylor, whose personal touch can be seen throughout *Tron*’s electronic world, reinforced and elaborated further. “There has never been a film that’s used this particular collage of technologies. This film really runs the gamut of techniques because we’re actually combining two opposites, in that, on the one hand, the computer simulation is an extremely new technology and is replacing very labor-intensive types of work, and on the other hand we are doing the back-lit compositing of the actors, which involves handpainting of hundreds of thousands of cels and as many as forty hand-flopped passes under the animation cameras per scene.”

Also very labor-intensive are the hand-done special effects animation techniques which provide essential transitional bridges between the live-action and the other effects. In addition to the classical glows and pixie-dust that special effects animation has been known for in such films as *Fantasia*, *Tron* features scenes involving interactive light effects composited with the live-action that will fool all but the most sophisticated viewers. These tricks are every bit as vital to the success and believability of the motion picture as the back-lit portions and the computer generated imagery, in that they provide just the right seasoning to make the main dishes a success.

Everybody working on the film has voiced the opinion that the credit for this movie goes to Steven Lisberger — “an energy ball,” as one person put it. They also point out that he persisted with *Tron* despite the customary proclamations that it could never be done. That Walt Disney Productions’ new management perceived the possibilities and put up \$17 million for the film is no accident, because the studio has been aware for quite a while that it was time to get back into the pioneering spirit — and this is a pioneering movie.

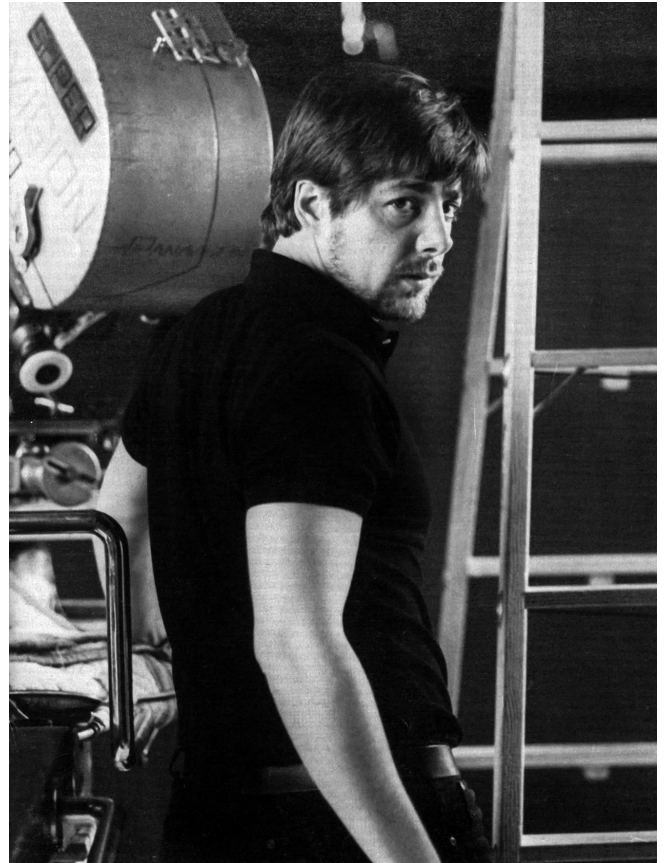
Lisberger began less than a decade ago with a small animation studio in Boston, where at its peak there were fifteen people working — mainly on commercials. Then he got the idea to do a feature-length animated cartoon for television called *Animalympics*, about animals playing in the Olympic games. The idea eventually grew into two projects — one for the winter Olympics and the other for the summer Olympics. To accomplish those two big projects, Lisberger moved to Los Angeles where he knew he would be able to find the forty skilled animators needed to complete the programs on time. Ultimately, the half-hour winter show was aired nationally; but because of the boycott of the summer games in Moscow, the hour-long summer show was seen only overseas. Long before they were finished, however, Lisberger was beginning to write *Tron*.

Lisberger formed a partnership with producer Donald Kushner to make the *Animalympics* shows. Kushner, with a background in both art and law, had produced several stage plays and had spearheaded the formation of the Boston Repertory Theatre. He was instrumental in helping Lisberger develop the story and design of *Tron* from the very beginning, and provided much of the momentum that kept the project rolling forward.

“I began working on the screenplay in 1977-78,” Lisberger explained. “The original intent was that I wanted to direct it and get involved in live-action feature film directing, because prior to this the only large project I had worked on was an animated feature. The best way to do that — to make that transition — is to write a property that a studio wants to make, but the only way they can make it is if they are willing to go with you as the director — which is what happened.

“I spent about two years doing research on the story, and there were an incredible number of drafts. One of the most difficult things about writing *Tron* was the fact that it was a totally alien environment, where whatever ideas one wanted to generate one had to think up from scratch. When you’ve got a fantasy world, you find that it’s incredibly exciting to be able to invent everything; but after awhile it can almost become an overwhelming task when you realize that every single aspect of the environment has to be generated. But I was really intrigued with the duality of the two worlds in the film. There’s the real world where the ‘users’ live, and there’s the theatre of the electronic world. The whole concept is based upon the idea that for each one of us there exists a body of information in the electronic dimension. Whether you’re in there through your driver’s license, or whether you’re in there because you’re writing elaborate computer programs, somewhere in there is you — on the other side. And the notion is that the two entities want to communicate and be in touch with each other. But that’s not always the way computers are designed. They can sometimes be more oriented towards a dictatorship, where you can’t reach your information unless you go through some master control program who decides when you can intercommunicate with the electronic world.

“I explored just about every way to do the film that you could think of — video composition, bluescreen. We storyboarded the film many times and eventually arrived at the techniques we’re using. It was always our intention to take advantage of the computer scene simulation capabilities, and I had kept abreast of advances in that area for two or three years prior to the writing of the



After three months of principal photography and nearly a year of postproduction special effects, writer-director Steven Lisberger’s production of Tron has emerged as a breakthrough effects film, incorporating an abundance of high-impact visual techniques which previously had been restricted almost solely to the realm of television commercials. Of the film’s \$17 million budget, approximately \$6 million went into back-lit live-action enhancement and another \$4 million into computer generated imagery.

picture. The whole idea was not to go to the computer companies and say: 'We want you — if you're so good with your computers — to generate a dog for us. Can you do that?' Well, of course, they can't. But we did know what they *could* generate. And the whole notion is that the things they do — the high-tech vehicles, props and landscapes that they're capable of putting out — lend themselves perfectly to our video-game land.

"The thing that's interesting to me is that the whole notion of computers has been incredibly barren of any visuals. I consider myself a visual person, and it was amazing to me that it's so literary and so filled with numbers. The first instance that I saw of high technology starting to orient itself to a visual side was through computer games — which is a perfect marriage. Computer games sort of create a bridge for people to appreciate the other capabilities of computers."

Although this film is very much the personal expression of Steven Lisberger's vision, nevertheless, the stylization and designing of the effects, the sets, the vehicles and costumes has certainly been a group effort. And of special note for having been involved in just about every aspect of the design and the look of *Tron* is veteran art director and effects specialist, Richard W. Taylor. Taylor, a master of several media-oriented art forms, started out as a painter and film student at the University of Utah. He put together a big traveling lightshow in the mid-Sixties, called Rainbow Jam, which toured with the Grateful Dead and did shows with everybody from Santa to the Utah Symphony. Then, shortly after getting a master's degree in print-making and photography at the University of Southern California, Taylor went to work at a new commercial production house that had just set up shop in Hollywood — Robert Abel and Associates. "While I was at USC, I started experimenting with the Oxberry animation stand, and when I got to Abel's I had my hands on some real equipment and started evolving ways of back-lighting that were the result of my experience in the lightshow business." In the years that followed, Taylor did a lot of commercials and television station logos that premiered what was to become known as the "candy-apple" look. He did a slitscan tunnel with the American flag for the CBS bicentennial station breaks, lots of logos and graphics for ABC, won four Clios (the equivalent of an Oscar for a commercial), and designed the primary miniatures for *Star Trek — The Motion Picture*. Shortly after that, he left Abel's and eventually became art director for the Entertainment Technology Group at Information International, Inc. — widely known as Triple-I.

"I was asked by Steve to handle the back-light techniques and to pull together a group of people who knew those technologies, and to invent a way of organizing that technology for a full feature-length film rather than a sixty-second commercial. Initially when I got involved with the project it was in the computer simulation area, because very early Steve came to Information International when he was forming this project up, and at that time the characters in the electronic world were going to be hand-animated. But he definitely knew that he wanted to use computers to do the environments. When he originally contacted Triple-I, he wanted a rough test of the computer simulation. The test definitely showed the potential. It showed that it could be done. And it was at that time I started getting involved in helping organize the overall film."

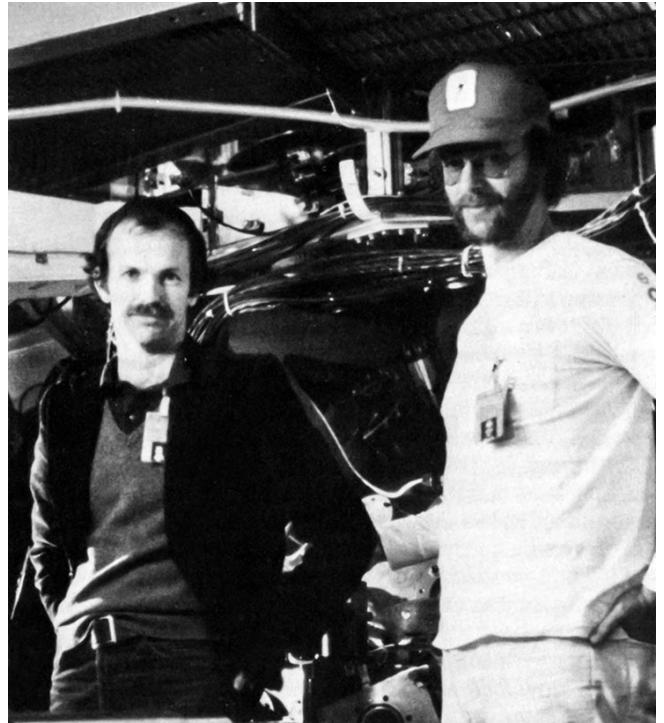
With his extensive background in animation, Lisberger first considered doing *Tron* with cartoon characters, along the line of *Heavy Metal*. But he decided it could be done better with live-action and he was ready for the change and challenge of working with breathing human beings. "I love it. What I really like is the closeness and the real-time aspect of it. In special effects, it's difficult to keep the

energy going because everybody's working on different aspects of one thing — in different rooms, at different times — and even though you exchange ideas as often as you can, it's still hard to sustain the mood. Whereas in live-action, when you're all working in that one environment, the team spirit is amazing. And a live performance makes it very exciting. I like to say: 'The actors are still the best special effects.' I'm so used to having to create something from nothing — whether it's an environment, or whatever — that when I get to work with a really good actor, I find it incredibly exciting. They can contribute so much."

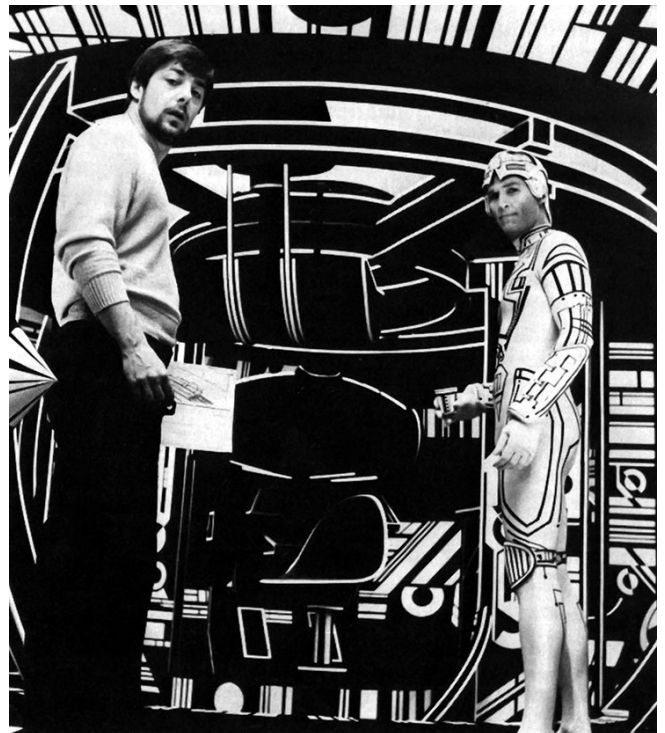
Lisberger and Taylor worked on the idea of shooting live-action in such a way that it could be used as a logical extension of the back-lit motion control photography that Taylor had used so successfully in commercials. "Bruce Logan did a very good job there," Taylor commented. "He was chosen as the cinematographer because he was one of the few who had a lot of miniature experience as well. He had done effects film work and had done a lot of lighting of miniatures. In a sense, shooting the electronic world photography was more like miniature work than it was live-action. The setups and the lighting were very tight — much more choreographed and worked out than a normal science fiction film where you're building a sound stage environment with a spacecraft that's dirtied up and the ambience is there. Those shots work when you shoot them, or they don't. In making this film, we literally had to make two films. We had to film the whole thing as a traditional live-action dramatic film, and then take two-thirds of that — fifty-three minutes or thereabouts — that which is the electronic game world, and put that through the entire process of turning it into single-frame, multipass animation. So, it's like making a regular feature first — very fast — then taking that and totally remaking it again like an animated film."

Soon after Lisberger secured the backing of the Disney organization, he brought on some top-notch design consultants to create vehicles, sets and costumes that would give *Tron* an especially sophisticated look. He borrowed Moebius (Jean Giraud) from *Heavy Metal* to design costumes which would take advantage of the back-lighting technique; got airbrush master Peter Lloyd to design and color many of the architectural backgrounds; and brought in Syd Mead, the dean of futuristic design, to create most of the vehicles and many of the sets for the film. "Steven almost gave them a blank slate," said Harrison Ellenshaw. "He told them: 'This is the story. Go nuts and design it!' So they did. That's very rare in a film. And much of what Syd, Moebius and Peter came up with has actually been used. We've used ninety percent of it, and very little of it got watered down or changed."

Syd Mead has been painting carefully thought-out visions of the future since the 1950s — and those visions have literally helped shape the present. He has consulted for many manufacturers, including Ford, American Motors, Volvo (the next generation of their cars is being influenced by his suggestions) and the Lancia Delta's interior. The Norelco shaver currently on the market is basically his design. Rather recently he has been in demand for motion picture work, starting with *Star Trek*, then *Blade Runner*, and now *Tron* — with more to come.



Special effects co-supervisors Harrison Ellenshaw and Richard W. Taylor.



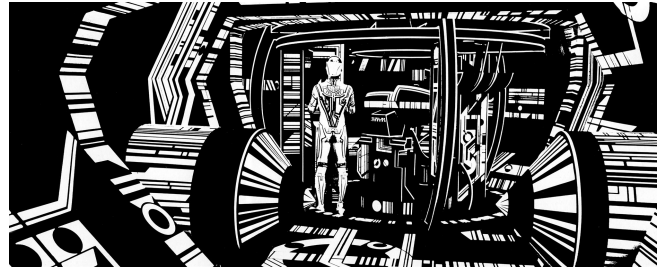
Steven Lisberger coaches actor Jeff Bridges on a set designed to represent a video game battle tank. All the sets and costumes featured in Tron's electronic world sequences were fashioned in stark blacks and whites, lit flatly and shot in 65mm by cinematographer Bruce Logan.

"I was originally hired by Steve and Don to do vehicular concepts for *Tron*. That included Sark's aircraft carrier, the light-cycles, tanks — and the solar sailer, which eventually Moebius took over. Once I had gone through those and Steve started to see what I was giving him, I moved into some of the terrain ideas — the canyons that the light-cycles race through, the game arenas, and the graphics on the game arenas. I also did interior sets for Yori's apartment, Sark's headquarters, the tank, the solar sailer and the binocular-like inside of the Recognizer. For the city complexes, Steve wanted something very different, and so we decided to sort of sink them into the terrain level — rather than have them built up — which produced a very sinister look to the whole thing. For Sark's headquarters we wanted a miniature arena — which I put on a platform — and then Sark's headquarters is sort of jutting-out, a semicircular fixture that revolves around the perimeter of this pit.

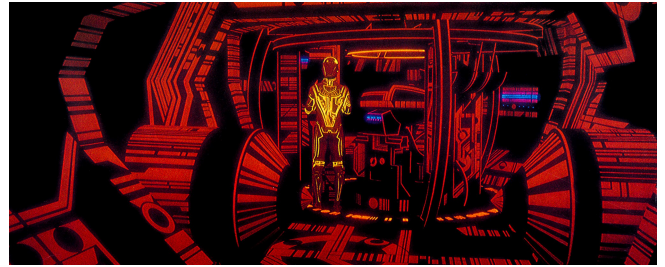
"Steve became fascinated with the look we were getting in the terms of solid — sort of solidified — graphics which matched the computer capabilities and the look of the electronic world that he was after. He didn't want to bias me to designing for the computer capability. He wanted to take an idea, and then confront the computer people and see what they'd do with it. I've worked with computer people — having been a consultant to Phillips Electronics, in Holland, for eleven years — and I already knew that if you design for the computer, sometimes you limit your contribution."

Mead's intuition for what things will be styled like a decade hence is what corporations are looking for when they hire him. "What they hire me to do is to provide sort of an eighty percent accurate guess about where they might be going. This can be as elaborate as working with their lab people and visualizing an accomplished engineering concept or marketing idea. Mostly this is for their internal consumption — to enlarge their visual vocabulary five to ten years ahead of what their production designers are working on. That also alerts management and corporate heads to get ready for what their design people might start to work on. Design staffs tend to get very insular, and design directors that I've worked for hire me deliberately to offset that sort of incestuous inbreeding."

While most of the production personnel who worked on *Tron* had made their reputations in commercials — and therefore had relatively little experience in feature films — one notable exception was Harrison Ellenshaw, who did many of the matte paintings for *Star Wars*, *The Black Hole* and *The Empire Strikes Back*, among others. Ellenshaw worked at Disney's for many years, then left to go to ILM for *Empire*, but returned to work on *Tron*. Actually, there is only one matte painting in *Tron* — a real-world shot of a vast office building interior — so he had little to do in that regard. Instead,



In the postproduction phase, each 65mm frame was enlarged onto a 12½×20-inch kodalith animation cel.



Then, by employing a series of reverses and holdout mattes, selected portions of the sets and live-action characters were brought to glowing life on an animation stand using back-lighting and color filters.

his duties as associate producer and co-supervisor of effects were much more wide-ranging. “I always enjoy matte shots because, as an artist, you’re responsible for one piece of film. No matter how short or long it is, you’re really a movie maker — you make a little bit of the movie. I think it’s a logical step to be able to just do more of that. We’re doing the same thing here — we’re taking different elements, throwing them in the hopper, combining them and coming out with a finished piece of film. Now there’s just more film that I’m responsible for.”

Tron is an example of a film that had its effects well planned out from the beginning. Still, many people were skeptical that it was too ambitious an undertaking. “That’s why Steven had to do a test before the studio bought the show,” explained Ellenshaw. “Many people thought that the possibilities for error were very great and that we would not be consistent in taking film and putting it onto one cel at a time — taking kodak transparency film and being able to process it and maintain consistency. They thought it would flicker and flash, and do all sorts of God-awful things. And now, the proof is in the pudding.”

The recipe for the pudding seems deceptively simple: “We shot on the animation stand like it was an optical printer, in the sense that we were hand-drawing all the mattes that were required — frame-by-frame, cel-by-cel — and they were all shot with back-lighting on the animation stand. Certainly, some of this could have been done on the optical printer. You could have shot some of it bluescreen for example, but that would have been far more limiting. Considering we have fifty-three minutes worth, it was actually faster to do it this way. I’d hate to think of doing fifty-three minutes of opticals!

“The fifty-three minutes of the electronic world was shot first in 65mm, on Double-X black-and-white film. The reason for the large format is to maintain quality. You take a piece of 65mm negative that has been developed and you put it into a photoroto — which is nothing more than an enlarger — and you enlarge each frame onto a 12½x20-inch piece of kodak transparency film. You process it with continuous-tone chemistry, and what you get out is what appears to be a black-and-white cel with a photograph on it. That is then taken and a contact



*A composite sequence of the villain Sark (David Warner) demonstrates the basic technique employed in generating glow effects in *Tron*'s electronic world. Using a rotoscope process, cel painters created a series of holdout mattes to isolate specific areas of the frame for back-lit enhancement. From left to right: Warner as photographed on the darkened stage; a rotoscoped "eye reveal" to give the eyes added intensity; a "face reveal" employing warm facial tints; a "circuit reveal" to add glowing colors to the suit; and the final composite. Each element required a separate pass through the animation camera.*



print is made of it on the same kind of film — but it's processed this time with high-contrast chemistry, so what you get is a high-con reverse of the first. Now, if there's a person in the scene, you have to produce a body matte to hold that person out from the

background. When you make the negative enlargement, the black lines that were the circuit designs on the costumes become clear, so we could light them up; but the black behind the characters also became clear, so we had to make what we call a circuit-reveal, and to do that you have to paint out all that clear area behind the characters. Then you have to make a matte for the face and the reverse of that — a face reveal — where everything is black but the face. And there we just add a little more exposure to the face, to make the face a little lighter than the body. When you put this on the animation stand, you combine photo elements with at least two cels. For example, when you do the backgrounds you always have to have a body matte over it. When you expose the circuit on the costume, you put down the high-con and the circuit reveal. Then you run through the one element, shooting it, and you back up the film, run through another element, back up the film, et cetera — as much as twenty-five passes on one piece of VistaVision film. We never went smaller than VistaVision. Since the release prints are in 35mm Panavision and 70mm, we shot in VistaVision to maintain quality.

"It's really beautifully simple. The complexity comes when you think about the *volume* of work. We have seventy-five thousand frames of live-action in the electronic world. That means we have seventy-five thousand continuous tones, seventy-five thousand hi-cons, seventy-five thousand body mattes, seventy-five thousand circuit reveals. Forty percent of the time we have face reveals and face mattes; fifteen percent of the time we have eye reveals. And we've got seven hundred backgrounds to worry about — some of which are set pieces that you may have to generate separate elements for, some of which are computer generated, some of which are painted. If you took all of the elements — not counting backgrounds — that we used on the film, and stacked them five feet high, that row would be fifty-eight feet long! I had to figure that out just to see how much room we would need to store it."

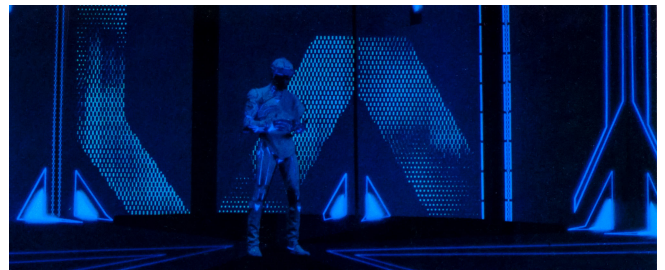
In essence, the live-action for the electronic world was shot in black-and-white so that it could be made into both positive and negative transparent enlargements which could then be used, in effect, as stencils for the backlighting. Syd Mead's sets were built as black-and-white interpretations of his designs; and the costumes also were made black-on-white. Sets were made from plywood, painted white, with the black part being velvet for minimal problems with the lighting. Costumes were white body stockings with black designs on them for the circuits, that could later be made to glow with the bottom-lighting process.

"The costumes were a difficult problem," said Richard Taylor. "We had a designer that we hired to interpret the original Moebius designs, but when we were less than two weeks away from filming I thought some of these costumes were embarrassing at best. The designer wasn't following the guide of the Moebius illustrations and they really looked like something from a 1940s B-movie. So there was a day when I flipped out, and I said: 'Steve, look, I'm going down to the costume department and I'm going to find some stuff down there, and I'm going to put it on myself.' Because I had done a lot of costume design in commercials — like that Levis spot — so I was familiar with

After a long day of placing and stacking the elements, he would take his desired progress on a single strip of film, seal it in a bag, and insert it into composite artwork or computer generated backgrounds.

costuming. So I put on leotards and athletic gear, and you could see that it would work. At this point we still didn't even know what helmets people were going to be wearing. This was less than two weeks before principal photography and no camera test had yet been done on the costumes! I could see I was going to be responsible for these things; yet I wasn't initially. When you get involved with projects like this, the main thing is creative worrying. All I want to know about are the problems — that which goes right we all expect. So there were two weeks of madness to get the costumes together. Every night I would take home different kinds of athletic helmets to experiment with, using black tape to lay out the patterns on them and on the other costume pieces. There were about ten characters that needed to be designed for the cityscapes — different weird electronic people and creatures, like the lightbulb man and the Oriental diode man. I would just tackle a few designs each night, and the following day the Disney prop and costuming departments would begin to work on them."

Working closely with Richard Taylor was technical effects supervisor John Scheele. Like everyone else on the *Tron* project, he described the experience not only as a unique evolutionary development in itself, but also in the context of the Disney environment. "Our challenge as a production was to come into this studio, with its tremendous history in pioneering animation photography, with all this massive camera equipment at our disposal, and get it converted over to computer control and to a whole new set of standards. Steve had spent six months in earlier tests just to prove to Disney that the process would work, and now the changeover had to be really pushed. On top of this was the constraint of time, working against a summer release when none of us could accurately predict how soon the effects could be wrapped up. Normally, Disney would allow four years to complete an animated film; but *Tron* has been thought of more as a live-action feature, even though each frame of the electronic world is individually handled and rephotographed. Nobody had actually done this particular process before — especially on a mass scale — and we didn't want to compromise the quality in pressing to meet the deadline. So my job has also been to expand the production base sufficiently to get the shots composited, and still leave time for reshoots and fixes of problem scenes. At least we weren't trying to jam the shots through optical printers. The whole collage of effects — photo cels, inked overlays, effects animation, backgrounds and computer generated plates — were all designed to be assembled on the animation stands to avoid that bottleneck.



Computer genius Flynn (Jeff Bridges) finds himself a stranger in a strange land when he is transported bodily into an alternate electronic world inhabited by anthropomorphized computer programs which are alter egos of the programmers who created them. Flynn's costume comes to glowing life as his circuits "rez-up" and his electronic surroundings materialize around him.



Captured by the forces of the despotic master control program (MCP), Flynn is taken to a holding cell and then sentenced to die on a video game grid where arcade-type games are life-and-death reality. On-stage settings were extremely sparse, with most backgrounds being artwork composites added later in the postproduction phase.

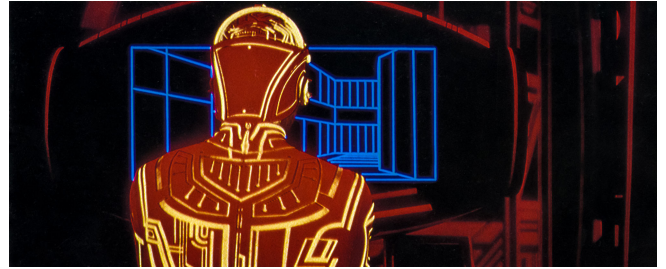
“One of our key problems from the start was to find a way to modulate the intensity curves of the effects during the picture, so that the viewer could stay with it without burning out his eyeballs! It’s one thing to grab somebody’s attention for sixty seconds on TV; but that kind of visual blitz would just be too much over fifty to sixty minutes of composited film. So one of the thrusts of the effects design was to create a dramatic tension in how we turn it on, tied into the story structure and action. Steve made up a map of ascending and descending curves — something we could orchestrate the effects to — and carefully chose when to pull out all the stops. To accomplish this, we had to create a system — with programmer Peter Blinn — for light animation that could marry up to the camera stands. We had computer controlled stepper motors on the camera drive and a dissolve shutter that allowed us to create intricate curves and waves of exposure. We also replaced the old quartz bulb light-boxes with neon, which is much cooler and doesn’t fry the artwork on long time exposures. Actually, only one stand was fully converted for motion control, mainly to give some ability to move the background plates and add depth to the shots. We weren’t really looking for an excuse to redo all the motion control streaks and tricks that everyone’s been seeing for the last five years. These effects are more in the art and the light modulation. That’s also why we were trying to keep away from opticals — all these soft glow and diffusion effects just turn to oatmeal when they go through an optical printer. But there’s still a tremendous burden on the camera operator with these long composites. They can run anywhere from two hours to a full week of shooting; and without a computer controller to help keep track of things, it can get pretty tense on day five. At least the exposure programming eliminated the need to enter and keep track of frame-by-frame time changes in the light.”

One of the animation cameramen whose job it was to shoot those thousands upon thousands of photo elements and overlays — where one slip-up could cost days of work — was Neil Viker, formerly with Hanna Barbera. “I’d come in in the morning and I’d drink about four or five cups of coffee to get myself awake, and in the space of twelve hours I’d try to shoot as many scenes as I possibly could. We worked in near darkness — almost like a photographic darkroom — because you have to have as much control of the light as possible when you’re back-lighting. For the most part, though, the work was just cel-flopping — your basic animation-type work.”

The drawbacks of conventional compositing have inspired research into other ways of compositing images, including digitally with a computer — scanning the film elements so they are converted to an electronic signal, manipulating and keying the images into each other, and finally scanning them back onto film again with a laser or a high-resolution cathode ray tube. But that technology is still in the experimental stages. “*Tron* could have been done entirely on a digital film printer,” said Harrison Ellenshaw, “and we wouldn’t have had to blow up the cels and there would’ve been no reason to have inking and painting. The film printer could have taken care of the matting. It would’ve been expensive to build; but whatever it cost, you’d get that back in one picture. *Tron* could have saved so much money, and then they would have had a beautiful film printer — and the next picture would be gravy! Anybody who has a digital film printer will have a path well-beaten to his door. It’s going to take some hard work, and then woosh! — all the optical printers go into the museums!”

A digital film printer was out of the realm of possibility for *Tron*, however. “In designing this film and the process to composite it,” Richard Taylor explained, “we had to generalize things down to a series

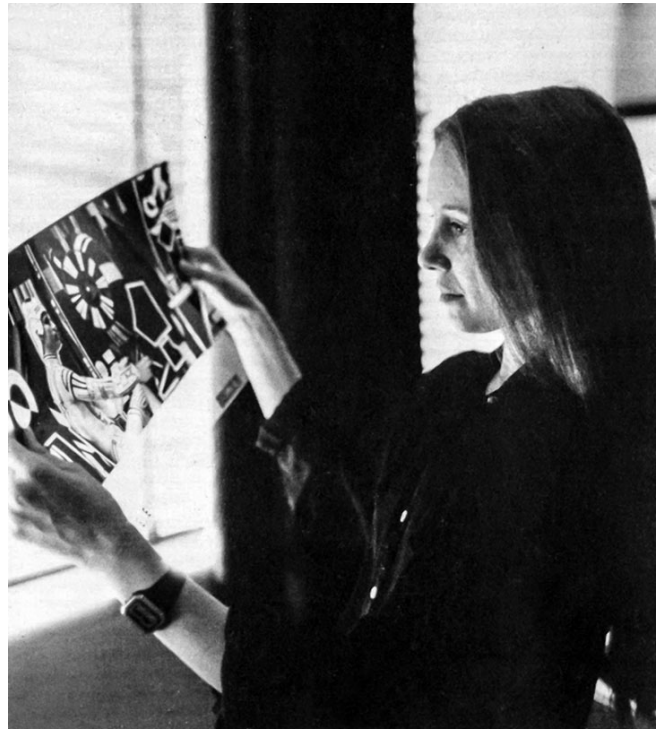
of givens that limited the amount of testing. The idea was to get things resolved, get the designs, techniques and equipment defined, find the right personnel, get the common vocabulary of the technique embedded in everybody's DNA — and then go for it."



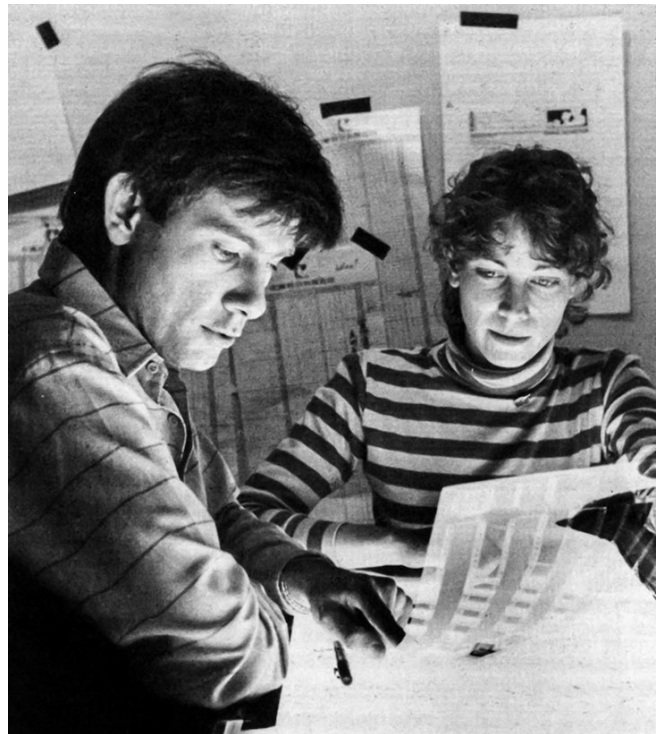
Engaged in a battle with the minions of the MCP, Clu — Flynn's renegade alter ego — maneuvers his video game tank through a vector representation of a computer-simulated corridor.



Using the live-action kodalith cel as a guide, Cathy Crum meticulously prepares one of the many thousands of holdout mattes required for the electronic game world sequences.



Scene coordinator Deena Burkett examines a kodalith of Clu at the controls of his tank.



After the various cels and mattes were prepared, exposure wedges were made on a single frame to determine proper coloration and light intensity for the entire shot. Scene coordinator Craig Newman and assistant Dana Duff select an appropriate wedge.

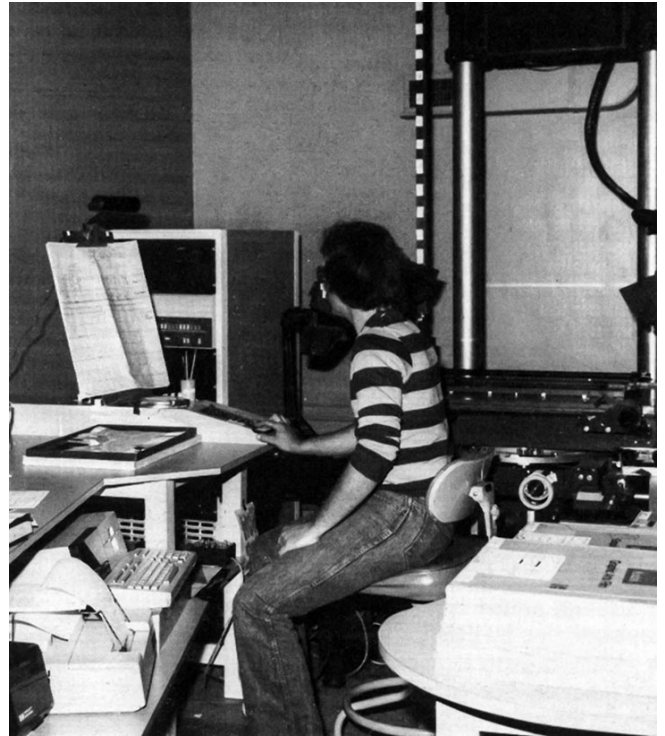
It is in the nature of back-lit animation that it requires intense supervision — traditionally provided by the art directors at commercial production houses. To be an artist in this medium, one must get into exposure timing and color filters as much as a painter does his brushes and oils. And like the other arts, working in back-lit animation requires much skill and experience before one can do work that has distinctive quality. Richard Taylor probably knows as much about the medium as anybody, but he couldn't possibly supervise all the scenes himself. In fact, it was necessary to hire ten assistants to parcel out the work. These assistants are called scene coordinators, and to get them it was necessary to tap the only talent pool available for people with these skills — the commercial production facilities. Each of these people is in effect an art director for his or her own designated portions of the film.

Deena Burkett is one of these scene coordinators.

Before joining the *Tron* project, she had done a number of commercials, including the recent Bank of America spot with the checkbook that curls up into a percent sign. And before that, she was on *Star Trek* — both with Douglas Trumbull, and before that at Abel's. "I have to be sure that all the people working on the elements of my scenes are working on the right parts and doing the right things. It's similar to working on a commercial, where you have to be aware of all the parts that are going into the scene and check on them, balance the colors, the effects filters and all the other little details. Working with people is very satisfying. In a way, that's the best part of this work for me — sometimes the hardest part — but still the best part."

Another of the scene coordinators is Peter Blinn, who also was with *Star Trek* when it was at Abel's, but moved on to build models for *Jason of Star Command* and animation work for *Buck Rogers*. More recently he was with Midocean Pictures where he was a technical director. "A scene coordinator has to keep track of the artwork. When it comes back from the ink and paint department, we make sure that every frame is in there and then we decide on the exposures for each of the passes. To do that, we experiment with different gels and different exposures on a single frame of each scene. That's called 'sample wedging.' When we get something we like with that one frame, we'll go ahead and shoot the whole scene. We have to do maybe half a dozen scenes per week."

An important contribution of Blinn's was the development of a computer program that varied the intensity of light for the glowing back-lit effects, freeing the camera people from having to adjust the f-stops on a frame-by-frame basis. "I was working on graphics on a Cal Comp plotter at Midocean, using analytic geometry in various incarnations. That experience in sinusoidal curves helped me to write a program that controls light intensity from one frame to the next in a

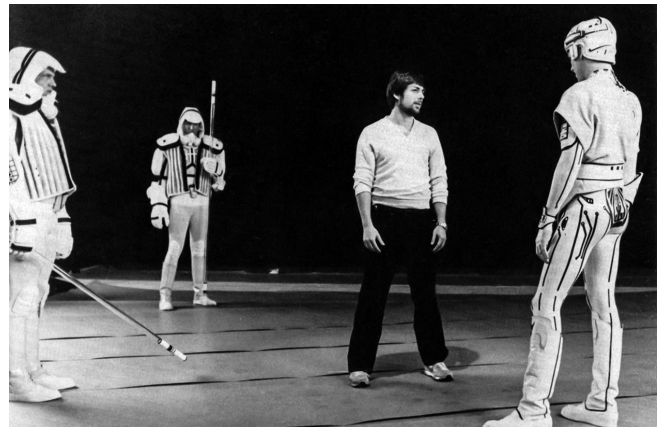


Animation cameraman Don Baker utilizes a custom exposure control system designed around a Hewlett-Packard 9826 computer running in tandem with a Cinetron 1100 motion control system.

sinesoidal way, so we can choreograph the lighting in a scene. It saves camera work because they just have to enter a few numbers before they start the shot and then not worry about it after that — it just clicks off the proper exposure, rounded to the nearest thousandth of a second.”



In life-and-death competition on the video game grid, an electronic warrior catches a soaring light pellet with his glowing cesta. The energy sphere, with its attendant glows and interactive lighting effects, was produced by means of back-lit cel animation.

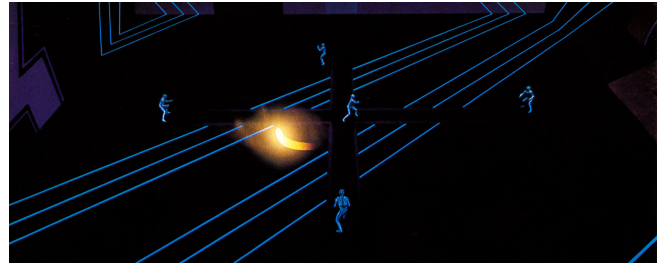


Steven Lisberger discusses another game sequence with Bruce Boxleitner, portraying Tron — the electronic world’s master warrior and staunchest adversary of the MCP.

Holding up a roll of super-fine mesh wire screen, Blinn said: “Most people around here were getting tired of the stars made from star filters, so we used stationary meshings, which are metal screens that are fine enough so they act as diffraction gratings — and in each tiny hole the light splits itself slightly so it gives you a rainbow effect. It splits a point light source into multiple images with four spikes on the star. If you watch closely, each of those images is spread with frequency slightly, so it’s reddish at one end and bluish-violet at the other. We used different sizes of them, and the finer the screen is the wider the distortion. There’s one scene where Clu [Flynn’s software alter ego] is being tortured up against a wall in the MCP area, and we did his circuits with two passes — one pass gives you the color as usual, and the other pass with white light using the screen filter. We also controlled the light with a light curve so that we’d have these starry spangled sparkles and throbbings.”

The scene coordinators’ work is sometimes very creative, but often tedious. And they can’t just go off on tangents — they must stick within the confines of what they’re told by Taylor and Ellenshaw. “The scene coordinator’s job is defined as much as I think it can be,” said Taylor, “and still leave enough rein for the creative people to enjoy it. Nobody likes to feel like they are just a tool of the production, especially if they are creative people — and among the group there are something like six Clios altogether. So they’re good people — they are hard to find, they have a particular talent that they’ve learned over the years, and you can’t just go out on the street and find people like that. But many of the scene coordinators — Michael Gibson, John Grower, Linda Stokes, Deena Burkett, Don Button and Peter Blinn — were people I had worked with before. Most of them came out of the commercial business and they were used to dealing with sixty seconds — and in sixty seconds you can literally do anything. There are no limitations to a sixty-second commercial. One person can spend a year of his life on a single commercial, and he can do every frame himself if he wants. But the dynamics of a feature film are such that if you’re doing special effects it has to turn into a cookie-packing operation. You have to have a process that pretty much becomes rote — that everybody can depend upon — so that if someone gets sick the whole thing isn’t going to fall apart.”

Tron was also a very complex project logistically, principally because of the frame-by-frame back-lit special effects work involved. In order to keep everything smoothly coordinated, a computerized frame-by-frame bookkeeping system of scenes was employed. Shelley Hinton, assistant scene coordinator to John Scheele, was responsible for keeping the system up-to-date. “I had to keep track of every scene in the film — its footage, the elements involved, and what was happening to them within each department. I put together a master log for the entire film, frame-by-frame, and kept track of it in a word processor. I’d get information from the editors and they’d tell me how long each scene was and what it consisted of; and from that information everyone would know what they were dealing with — whether the scene was to be shipped overseas for ink and paint application, and so forth. The data was also vital to Michael Fremer who was doing the sound effects electronically, since any changes that the editors or directors made were reflected in the log’s daily



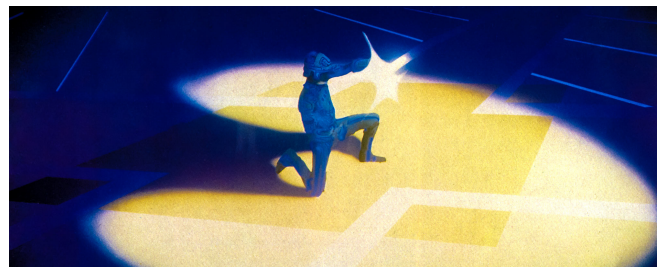
Played out on a barren soundstage, the game action was later incorporated into an expansive vector graphic setting, with Tron dodging deadly light pellets hurled by four opponents.

update. Once a week I made a print-out of about twenty-four pages and sent everybody a xerox, just to keep them informed of the changing length of the scenes and of the shooting schedule. It became an organizational mainstay, and everyone in the department referred to it. Without it, there would have been chaos. We started out with charts that were penciled in and changed by hand; but the word processor was really the most efficient way, because everything could be kept on the floppy disc. If we'd been doing it by hand, it would have been a mammoth task — it would have taken a whole team working full-time.”

While the back-lit effects in *Tron* stand out as the most obviously novel thing about this film, the computer generated imagery may go by the average viewer relatively unnoticed. Many will probably think the computer generated scenes were accomplished with miniatures, stop-motion or even cel animation. But people familiar with those techniques will immediately be aware that an entirely new technique — unlike anything else — is being employed, and that one thing after another is being done that would be impossible by any traditional method. With computer generated imagery, it is possible to have an object change its shape with a metamorphosis effect — called “interpolation” by the computer people. Or it is possible to “really blow-out the point of view of the camera,” as Richard Taylor put it. “We move it through objects and fly from micro to macro positions.” And simulated objects can be made to move in any way at all — unrestricted by pylons or track length the way models on motion control systems are. Creating scenes with CGI is like having at your disposal a flawless airbrush artist who can paint thousands of paintings a day with photographic realism, getting perspective and shading absolutely perfect — and without any discontinuities in the dimension of time, either.

The computers that do this work must be programmed with formulas on the nature of light, optics and the geometry of perspective. They take all that, and more, into consideration when they generate the scenes a director has asked for. Though it's an incredibly complex subject to get into, essentially it's very simple. You tell the computer what the shape is of the object you want to animate, its color, its motion and where the light is coming from — and from there, the computer just calculates what that image would be, point-by-point across the picture, and displays it line-by-line on a cathode ray tube, similar to the way a TV picture is generated, only slower and with higher resolution. Said Harrison Ellenshaw: “Once you get into it, even a layman such as myself — and I certainly know nothing about programming — can understand the basic process and how it's accomplished. Then you can get it. But it's difficult to explain Kleenex to an aborigine.”

It does not take a crystal ball, however, to see that this technology, still in its earliest formative stages, will eventually become one of the most important developments in the history of media — not only for its ability to do the impossible in terms of special effects, but because eventually it will be possible to substitute simulated scenes for location shooting and expensive sets in all kinds of productions. And while at present it is very difficult for computers to generate images of organic things like plants and animals, research into those areas is advancing



Using his identity disc, Tron deflects one of the cel-animated energy spheres hurled at him by a video opponent. Augmenting the back-lit circuit effects used throughout are interactive lighting effects from the light

rapidly. So it's just a matter of time before there will be entire software zoos and botanical gardens available to work with, just as there is presently a rapidly growing inventory of vehicles and architecture.

Using his identity disc, Tron deflects one of the ceiling's energy spheres hurtled at him by a video opponent. Augmenting the back-lit circuit effects used throughout are interactive lighting effects from the light pellets — on both Tron and the composite artwork floor — created by the effects animation department.

Some of the first computer generated scenes completed for the movie were of the light-cycles. When effects animator Dave Stephan (who does all of his work by hand) saw them, he echoed everyone's initial reaction on their first exposure to CGI: "When those cycles turn the corner, skidding and tilting and rushing towards the camera, I thought: 'Wow, that's great stuff!' I wanted to see more of it; I wanted it to last all day."

Richard Taylor was involved with the CGI work from the time Lisberger first came to Triple-I to explore the possibilities for using digital scene simulation in *Tron*. "Other than the back-lit part, my responsibility extended to the computer simulation design and coordination, so that it fit into the whole process and so that everybody had a common vocabulary. This film is really the first full-blown use of computer simulation as a regular production tool. It's not just one little vignette — we did a lot of footage.

"I looked objectively at the film across the board, and it was immediately apparent that no one of the computer simulation companies was going to be able to handle the load. Each has its own hybrid system, and none of them shares common software or techniques — each one has its own way of looking. Plus we decided that we wanted to composite this film in VistaVision, and none of these places — other than Triple-I, who were starting to work in VistaVision with their digital film printer — did VistaVision film recording. All of the companies had to convert to VistaVision and to our alignment system. We had to create a system that everybody agreed upon; and then we had to create our own field charts, animation exposure sheets and everything else right down the line. It was just like building the whole thing from scratch. Everything from the labels on our boxes to the way we define the names of objects and elements is all unique to this particular film. So I looked at the computer work to be done on the film and decided that we'd have to break it up among two or three companies. Then, stylistically, I tried to decide, by the kinds of techniques the different groups had, who should do which parts. As a result, Triple-I dealt with the part of the film that used the more complex craft and images, and MAGI [Mathematical Applications Group, Inc.] dealt with some of the more elaborate choreography. The load was equally shared and both companies did a super job. MAGI did the first half of the movie and Triple-I did the latter half, because there's a very specific stylistic point where things change — from the solar sailer on out. They're leaving the game grid and heading off to the MCP's domain, and the simulation gets more and more real as you get closer to the MCP.

"With MAGI's system it is quite easy to choreograph the object, and we got motion tests from them very quickly. There are some limitations to the nature of the objects that they create. As a matter of fact, as a result of doing *Tron*, they've improved a lot of things in their systems, because I asked that they implement some things like depth-cluing; and they didn't have transparency. We challenged them to implement and they responded.

“Triple-I’s system is different in many ways. MAGI computes the scenes off to tape and then the tape plays the Celco film recorder. So when it’s actually filming it’s very dependable. Triple-I has a unique hybrid system. Everything that is a shaded picture goes through one central processor and plays that off to a high-resolution film recorder. But it has to process everything linearly, which means that you have to go through motion tests, set the look of key frames and shoot production on that system; and so its dependability has everything to do with how it will run. If it breaks, their productivity stops. So part of their improvement was to make their equipment more dependable so they could run without glitches. In computer simulation that is the biggest problem — even the best systems have glitches, or some other occasional artifact.

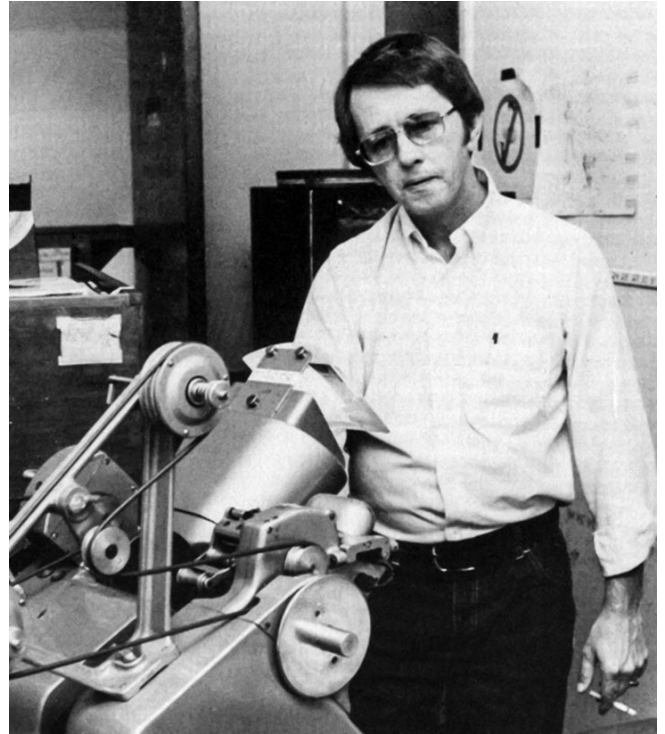
“Part of my responsibilities in handling the simulation was to educate everybody in the film to the potentials that were there — to make sure that if we were going to make a camera move that we’d do something you wouldn’t normally do with traditional miniatures, to keep people thinking in terms of what simulation can do that’s different than traditional filmmaking. The thing I kept trying to emphasize was to use computer simulation for its unique qualities and not to imitate some other reality. Really try and make both the design of the objects and choreography unique to that technology.”

In order to generate the fifteen minutes or so of digital images needed for *Tron*, the two primary CGI facilities — MAGI and Triple-I — were kept working full-time on the project for the better part of a year. In addition, two other companies supplied cameo CGI scenes — Robert Abel and Associates, who produced the opening title sequence and the transition to the electronic world; and Digital Effects, Inc., who did the “Bit,” a little geometric sidekick that floats around accompanying the hero in the tank battle sequences. (The word “bit” is computer terminology, meaning the smallest unit of information possible — 0 or 1 — represented by the electrical signal being either off or on.)

Scene coordinator Deena Burkett was in charge of the scenes in which it appears. “The Bit is a character who floats around inside the tank with Clu — Jeff Bridges. And Clu talks to the Bit while he’s driving around fighting bad guys. The Bit is always changing back and forth between two geometric shapes that mean ‘yes’ and ‘no.’ To answer questions he stops changing for a moment — the octahedron shape means ‘yes’ and the spiky shape means ‘no’ — but most of the time he’s floating around just mumbling to himself. Originally, the Bit looked something like a billiard ball, but as time went on we realized that it’s hard to make a sphere show expressions. The final design for the Bit was worked out by Richard Taylor and animator John Norton, who was with the Bit from the beginning when Syd Mead first came up with the idea.”

Along with all his other duties, Richard Taylor designed the *Tron* logo and opening title animation that was done at Robert Abel's. "I felt that we needed a symbol for this film that was a new-looking logo. Syd Mead and I designed the typeface; and when we were all happy with it, I storyboarded the title sequence. Having worked at Abel's and knowing their capabilities and having great respect for them, I wanted to do some work there. I knew there were certain things they could do that would just fit perfectly into the style of the movie. So when I storyboarded the opening title sequence, I didn't try to fit a square peg into a round hole. I didn't want them to invent too many new things — I just wanted to nail it. You do these things as directly as possible because you don't have the luxury of fiddling around with every little detail when you're doing a feature of this size."

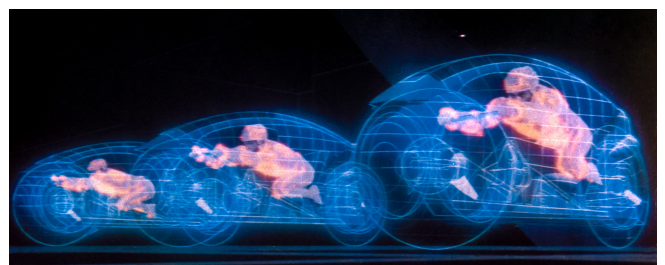
Syd Mead, on the other hand, prefers to intentionally ignore the needs of the computer graphics systems when he designs things for them to generate, because he feels that it's important to force the computer (and its programmers) into new areas of stylization. Having paid scant attention to the computer's needs, Mead expected it might well have difficulties with his designs. "The surprise was that the tank went through very smoothly, because it's essentially a rectilinear solid with rounded edges and MAGI has a program that they can apply to the edges which just sweeps off the corners with a constant radius. The light-cycles, on the other hand, were very difficult — matching what is essentially a rounded blade shape onto a ball which is the front wheel. One of the problems with generating computer simulated scenes is that the more complex the 3-D structure is, the more expensive it is to create it. So in designing for these systems one tries to avoid the kind of complex 3-D detailing that is currently popular in miniatures. We didn't want to get into designing three-dimensional niches, nooks and crannies. The problem was to get visual texture without getting really very complicated. So, I



Effects animation supervisor Lee Dyer studies a sequence to be enhanced by his department.



One of the film's more intriguing applications of cel animation was for a sequence in which light-cycles form around Tron and two other video warriors. The stage photography was shot with Bruce Boxleitner positioned on the bare rudiments of a prop light-cycle.



introduced flat, optical-scanner-like bar graphics — the kind you find on packages in the supermarket — as the answer. I knew they would be familiar to the audience. We used them in the channels. They infer a right-left bias to the channels, presumably for the benefit of the vehicles.”

Then, over the live-action and back-lit circuit glows, the cycles were made to “rez up” around the riders through cel-animated vector graphics.

Just as the back-lit portions of *Tron* were so complex that they required several scene coordinators to share the creative and organizational work, so also the fifteen minutes worth of computer generated scenes required two people functioning as CGI choreographers, to plan the action and setting for those scenes. Starting with the vehicles and objects designed by Syd Mead and the others, and working closely with Steven Lisberger and Richard Taylor, were two young explorers of visual dynamics with impressive backgrounds in cel animation — Jerry Rees and Bill Kroyer. Their highly developed sense of motion and the other subtleties that go into classical animation made them well-suited to the task of choreographing the action in the synthesized environments created by the digital painting machines. Kroyer, who was the animation director of *Animalympics*, was with *Tron* from the very beginning. Before that, he had worked for several years doing animated commercials, and for a while he was with Disney, working on the *The Fox and the Hound*. It was then that he met Jerry Rees, who had earlier worked on *Pete’s Dragon* and *The Small One*, and who had been doing top-quality animation since he began at Disney’s as a teenager.

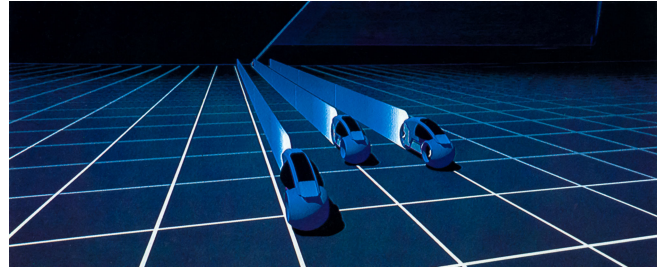
“*Tron* is setting some precedents that will be springboards for a lot of spin-off developments,” Rees predicted. “Computers are so exciting — the horizons are endless. I think they are the most significant thing that’s come along, because with them there are fewer steps between the artist and the film. It seems like the artists are getting closer to the final product with this new technology.”

Because the *Tron* project was so big, the studio was forced to bring several large trailers on the lot for additional work space. Kroyer and Rees worked in one of these temporary studios, where they had their desks, some basic drawing tools, and most importantly a computer display terminal that hooked up with the big computer at MAGI — located across the continent, in Elmsford, New York.

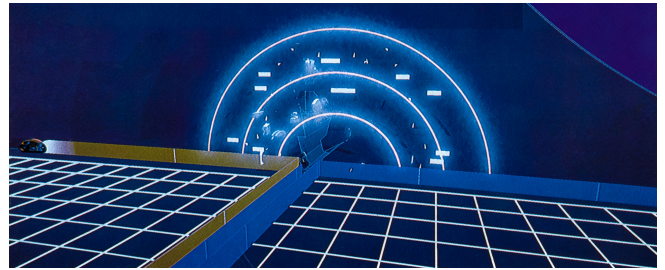
“The terminal was a Chromatics 9000,” Bill Kroyer explained, “hooked up by a phone modem that received binary signals over the phone lines from a modem on the computer at the MAGI facility. Their computer generated the binary blips that the images consisted of; and with the phone hook-up it sent those blips to us and our Chromatics reproduced the digital picture. We couldn’t do any programming on the Chromatics — it functioned just as a monitor to receive and view the animation coming from MAGI. We could change the speed of the animation and view it in different ways, but we couldn’t actually create the scene.

“To plan a scene, Jerry and I worked out the basic action of a sequence with storyboards. We’d go over it with Steve, and then break down the scenes into animation frames. We’d do rough storyboards of all the main poses within the scenes so that the computer operators could understand the look we were going for and the action. But we’d give a much more detailed description of the scene by outlining the speed of the objects, the architecture, the environment, the lighting, color and texture. We defined everything in the scene — every movement, every color and every action we completely wrote out in terms of distance, direction and time. The computer operators were then able to take all those things and translate them into cold, hard numbers. After

that, their computer would send our computer a low-resolution test, generated with just eighty scan lines of resolution. The tests looked kind of blocky, but we could see enough to tell if the staging, action and timing were what we asked for. It's a very inexpensive way to look at the scene because the computer doesn't have to generate several million pixels as it would have to do on a high-resolution picture. Since it is such a very low resolution and the computer is generating so few pixels, it is possible for it to send those few pixels over the phone line fairly quickly, so we could view the tests almost immediately on our CRT.



Once solidified, the light-cycles tear off across the game grid to engage another team of opponents. At this point, the sequence becomes computer generated, with the high-speed light-cycle footage generated by Mathematical Applications Group, Inc. (MAGI) — one of four computer imaging companies involved in Tron.

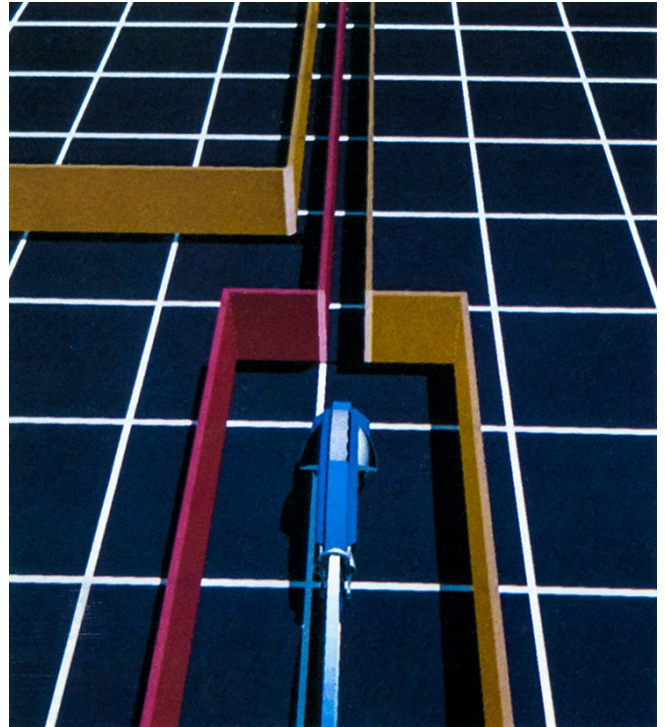


Racing along at breakneck speed, the cycles slice into right angle turns without even slowing — but if an opponent fails to maneuver a turn, or collides with the trail left by another cyclist, he is destroyed.

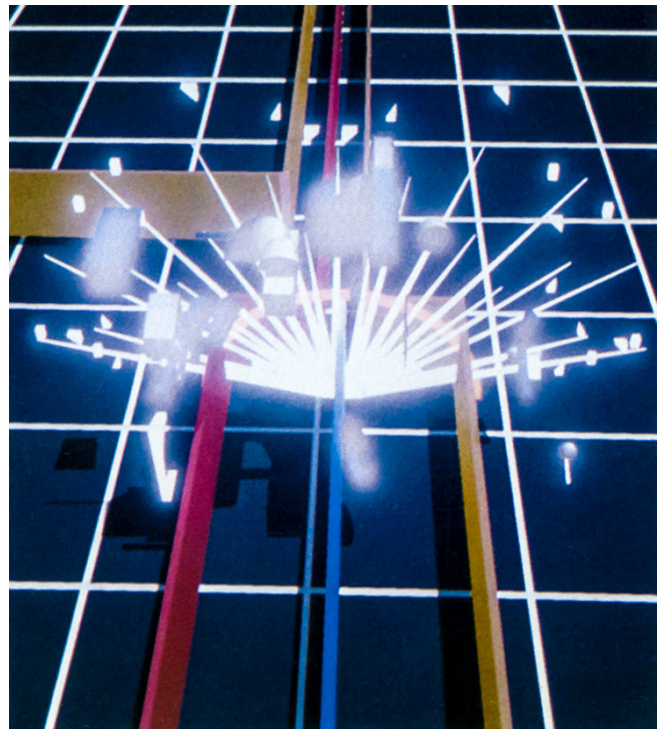
“But we didn’t have this display terminal system when we started on the movie. In those days, MAGI would photograph the tests on black-and-white film, send them to us through the mail; we’d view them, call MAGI on the phone and react to them; MAGI would then film a correction, send that to the lab, get it back, send it to us; and then usually at that point we would be ready to go for a ‘hero’, or high-resolution. So for a typical scene we might have four or five days between the initial test and the okay for final high-res. But with our Chromatics, they’d put their phone in the modem device and immediately send us the low-resolution scene. It’d usually take about an hour for our terminal to receive and translate the blips into all the frames we needed. Then we’d punch a button and view the scene, and we’d call them back and react to it. We’d give them the corrections, and then they’d immediately program the corrections and send us the scene again. So in a matter of four or five hours we’d have a chance to see and respond to the scene twice — which was usually all it took for us to go for a hero. As a result, we cut our time down from five days to five hours. It really speeded up the whole process and allowed us to have a more efficient time flow and scheduling. And from the creative point of view, it was much more stimulating to be able to work on something and get that done before moving on to the next step, rather than having to be working on several scenes at once.

“We were also able to get one high-res picture at a time — in about nine minutes. The system could give us up to a thousand black-and-white pictures to view in motion; but when it came to full-color, high-resolution, we could only get those singly. So we couldn’t see color motion. But we could see color stills, so we were able to check and see that the shadows and color and all those things were correct.”

John Norton, who worked for the most part with hand-drawn effects animation, had an opportunity to keep an especially good overview of Rees and Kroyer’s choreography, since their territories overlapped somewhat. “One of the interesting things

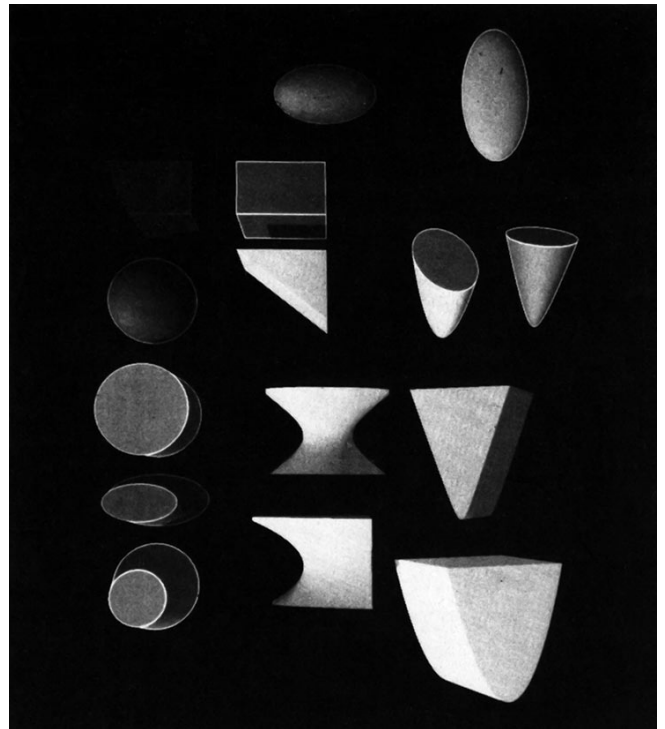


Unable to avoid the converging trails of his opponents, an ill-fated light-cyclist is smashed to atoms.



Unable to avoid the converging trails of his opponents, an ill-fated light-cyclist is smashed to atoms.

about Bill and Jerry,” he said, “is that they’re both Disney animators. And in laying the moves out for the computer, they were putting in a lot of organic movement — ease-ins and ease-outs, anticipation and follow-through. You’ll notice that in the scenes with the light-cycles. At first they’re confined to a game-board arena and move mechanically there — with all this right-angle movement. But once those light-cycles break out of the arena, there’s this really nice shot of them taking this beautiful curve, banking and turning as they escape. I don’t think computer animation is going to replace conventional animation. It’s just another tool for the animator. I think it may someday replace some of the labor — ink and paint and in-between. But the animator will always be there using this new tool. It only takes a minute after seeing the computer stuff to know that it’s here to stay. And I love the metamorphosis effect. The Recognizer I designed has these two arms it can merge together into one big pogo-stick, which it then uses to stomp on things.” [There’s a very definite old-time cartoon flavor to some of this new-fangled stuff, to be sure!]

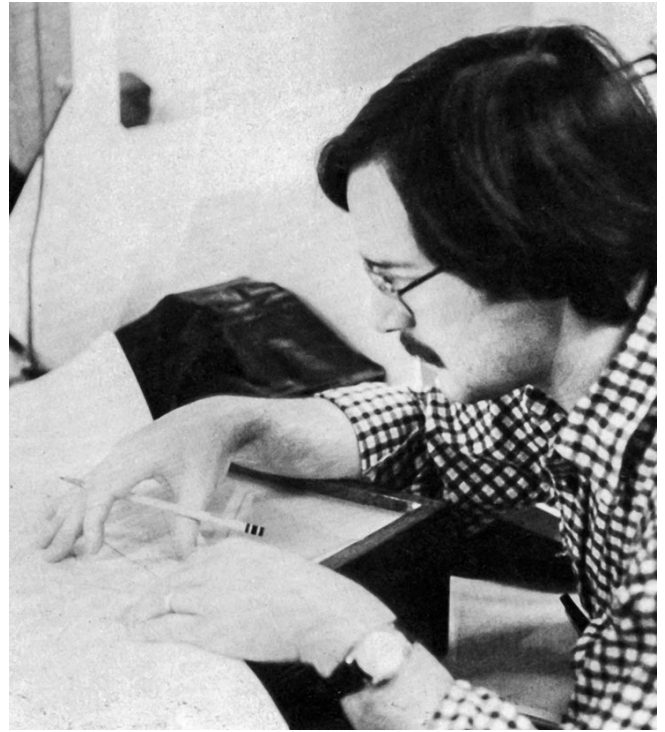


Unique among digital imaging companies, MAGI forms its computer generated subjects by adding together or subtracting out “primitives” — geometric solids in a wide variety of shapes and variable sizes which are pre-programmed into their computer for ready assembly into whatever shape is desired.

Bill Kroyer and Jerry Rees planned the CGI scenes on the West Coast for production at MAGI's facility in New York, from which the scenes were transmitted back to the terminal Kroyer and Rees used for their approval. Larry Elin was the person at the MAGI end of the transcontinental data link-up — in charge of the production team there which included Nancy Campi and Chris Wedge. MAGI's process, called Synthavision, is unique among CGI production methods. "In our software," Elin explain, "there exists what you could think of as three-dimensional volumes. These are pre-programmed primitive shapes that are already in the computer. There are spheres, cubes, cones, ellipsoids — those are some of the simple ones. There are also free-form bodies like hyperbolic paraboloids. It's a lot like building with blocks. Everything that we build in our system is built from these simple shapes. They can be added to each other or subtracted from each other, made larger or smaller and their proportions changed in any way, making it possible to make complex-looking things. This process is called combinational geometry — or solids modeling."

All other digital imaging systems use a different method based upon forming the objects out of lots of little flat surfaces, like the facets of a gemstone, and thereafter calculating the light that strikes these polygonal facets and how much of it reflects into the theoretical camera lens. But it turns out that one of the most time-consuming aspects of that kind of software is the time it takes for the computer to figure out which objects and parts of objects are naturally hidden from the camera's view. "One of the good things about the Synthavision method is that we don't have hidden lines to sort out. So the calculation time is really small compared to the time required when you build a picture out of polygons. The problem solves itself with our ray-tracing process."

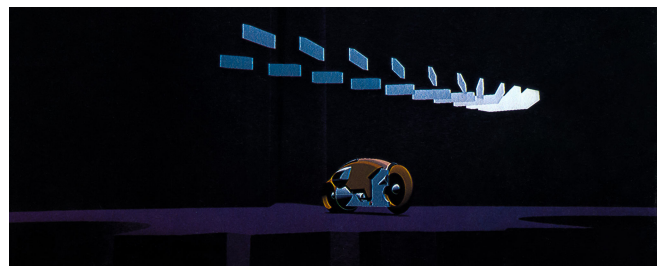
For the folks at MAGI, it turns out to be a lot simpler to trace the light *backward* from the imaginary camera, rather than to calculate all the light that might or might not be coming towards the camera. "We actually fire rays from the camera at the scene, one ray for each pixel. So everything naturally



MAGI computer graphics head Larry Elin studies blueprints and storyboards provided by the Disney CGI coordinators.

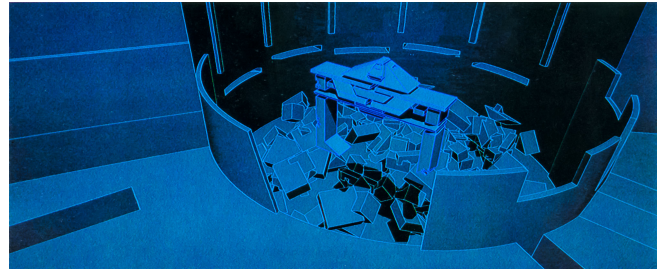


A MAGI-generated battle tank fires a deadly burst of electronic energy.



The tank salvo passes over a speeding light-cycle.

takes care of its own hidden lines because the first thing you hit accounts for that particular pixel. At some point along the way it'll hit something, and then the computer figures out at what angle it hit it. That angle's relationship to the light source will determine what grey level that particular point of color should be." In effect, what is out of sight is out of mind for the MAGI computers.



With Flynn at the controls, a demolished police robot, or Recognizer, emerges from a video game junkyard and reassembles itself.



Computer image choreographer Bill Kroyer previews a series of frames at a Chromatics video terminal linked up via telephone to MAGI's master system located across the continent in New York. The images, though low in resolution, allowed Kroyer and associate Jerry Rees to preview an in-progress shot within minutes of its completion and direct any desired alterations before the scene was played out in high-resolution.

The founder and president of MAGI — oldest of the CGI operations, dating back to 1966 — is Dr. Phillip Mittelman, who is a physicist, not a programmer.

“We were in the business in the first place to do calculations involving nuclear radiation transport; and so everything we were doing had to do with tracking rays through things. The company was working on these radiation problems, and the techniques we developed were something where you describe the real world in terms of three-dimensional objects. We’d trace radiation — neutrons and gamma rays — through this three-dimensional world; and we observed that if we traced *light* rays around, instead of neutrons and gamma rays, we would, in effect, simulate photography. And that’s the basis of our whole idea — a true simulation of photography.” In essence, MAGI evolved their unique method of working with geometric primitives because when they were dealing with radiation the objects they were concerned with had to behave as though they were solid objects — it was not sufficient to just concern themselves with the surfaces of things. Now, of course, solidity no longer matters in their computations, but the legacy of their early work lies in their hidden-line-free way of doing things.

“At one time we showed our work to some people and they said, ‘My gosh, you’ve solved the hidden line problem!’ We said, ‘What’s a hidden line problem?’ We were quite naive. We were totally independent and out of touch with the world of picture making that was going on in Utah, and places like that, where they were making images the more common way, with polygons and so forth.”

“You don’t have to be a programmer to use the Synthavision system,” Larry Elin explained. “In fact, all of us on the production team come from film, art and animation backgrounds. The work we do is very much analogous to motion control systems, except that instead of using real models and real cameras, we’re just generating the pictures based on instructions that we give to the computer. In effect we build these models, but we build them digitally into the computer. Then we define the motions that we want these things to go through. And the same for the motions that we want the camera and the aim point and light sources to go through. So we build models, but we don’t build real models — we build mathematical models. And we program motions, but we’re programming the motions for these mathematical models — not for things dangling from the ceiling on wires or anything like that. In a way, we are akin to stop-motion animation, but we’re not limited by real solid objects. We’re dealing with things that are really just ghosts! So we describe these things and motions to the computer, and the computer is able to calculate what these pictures would really look like if everything were just the way we described them.



The crippled Recognizer cruises Tron’s electronic game world.

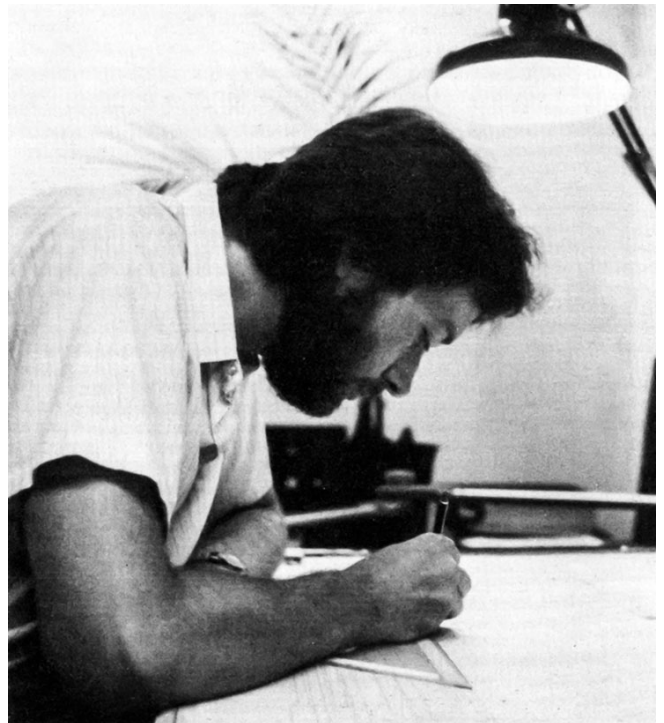
“The first step in our process is to build whatever it is that we want to animate from these simple shapes. The next step is to put the objects all into the scene together — in the places in three dimensional space where we want them to start when the scene begins. Then we put in the movement commands, using our ‘director’s language.’ The next step is to select some key frames to look at — to make sure that all the commands we’ve fed into the computer are really making happen what we want it to do. So we test the input by calculating some key frames. Once those frames are calculated we can look at them on a one-thousand-line screen CRT; and from there it’s easy to determine whether or not we need to make some changes in our input file. The next step is to calculate what we call a pencil test [a term appropriated from conventional animation, which refers to test films of the animation in its earliest pencil-drawn stages] which is a low-resolution, black-and-white line drawing animation of the scene. Usually we can do this in a very short period of time. Most of the scenes in *Tron* were an average of about three-and-a-half seconds long — or about eighty-four frames — and we could calculate eighty-four frames in about an hour. Then we viewed them at speed on the monitor. At that point we could modify movements. If we didn’t like the way something was moving, or if we thought something was moving too slow, we could make those changes. Then it was time to let the Disney animators, like Bill and Jerry, see what we’d done. So we’d transmit the same pictures we’d been looking at on our monitor over the phone lines to their monitor in California. Then they’d tell us whatever modifications they wanted us to make. Once it got to the point where we all liked what we had, then we’d compute and photograph the scene at high-resolution — in VistaVision format — and that was the finished film that we delivered to Disney. Our high-resolution would be the equivalent of eighteen hundred lines if it were on 35mm.

“We also provided pictures which were used by the Disney painters as guides so that they could paint backgrounds for use with the back-lit live-action. They’d paint an exact duplicate of what the computer scene looked like, because then they could shoot it on the animation stand, which saved them from having to go through opticals.”

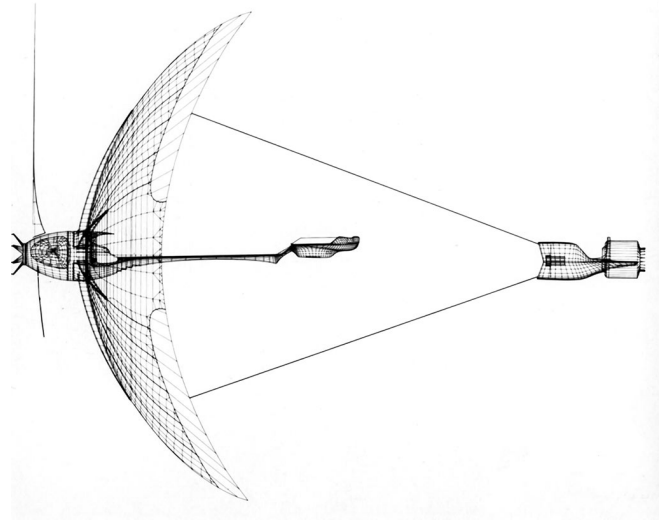
In contrast to MAGI’s combinational geometry and ray tracing, almost all other CGI companies use methods similar to those employed by Information International. Triple-I’s approach works best for creating complex objects with elaborate coloring and simply stunning surface characteristics. Their engineer, Bill Dungan, spoke about some of the features of the system; “We have a program that was written by Craig Reynolds for his master’s thesis at MIT, called ASAS — Actor/Scriptor/Animation System — and it’s with that program that we choreograph our scenes. Not only do we control movement, but we also control colors, lighting and all our parameters. You can animate everything independently and change colors all over the place. What comes out of this is the format for our shading program, which is called TRANU — the New Transparency Algorithm — which has had codes added to it over the years by many people, like Jim Blinn, Frank Crow and Gary Demos — who did a lot of things — and I think it actually started at Utah, where so much of the early work was done.”



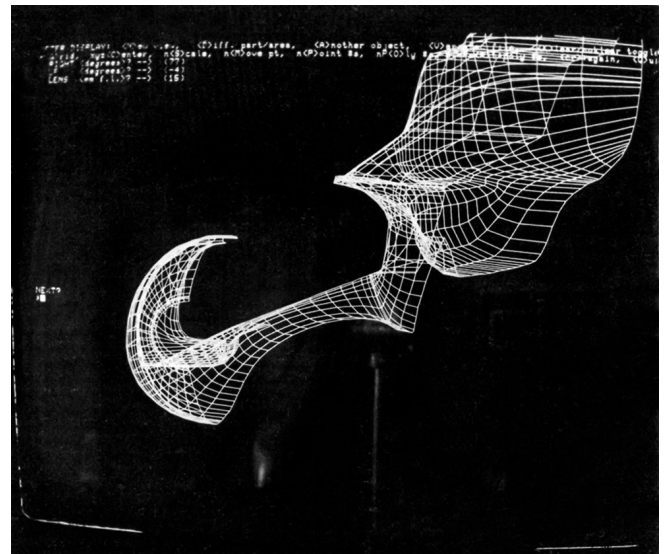
Steven Lisberger reviews a series of preproduction sketches with futuristic designer Syd Mead.



Information International's Art Durinski blueprints one of three views (front, side and top) of Sark's airborne carrier. Triple-I uses these blueprints to digitally encode the shape of any given object into their computer. Once that has been done, the computer has a three-dimensional representation of the object in memory and can conjure it up from any perspective.



The underlying data base for the solar sailer as encoded in the Triple-I computer.

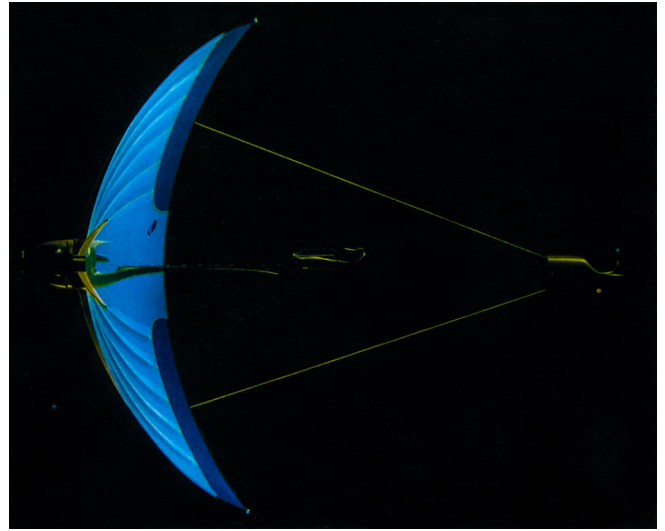


The solar sailer passenger module displayed in vector form on a video screen.

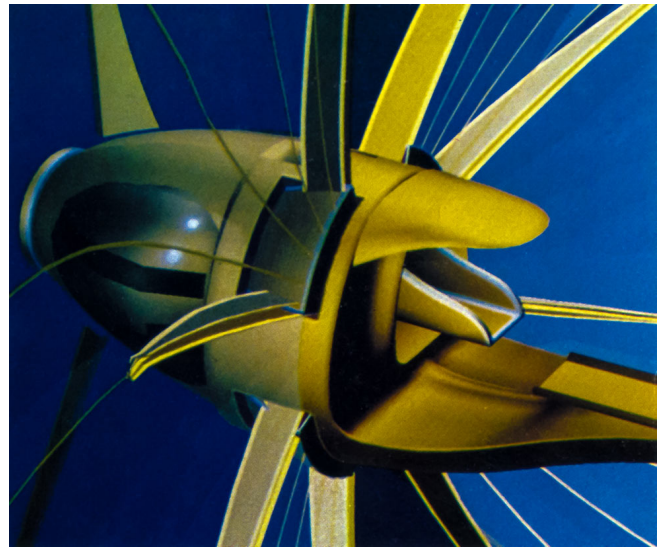
Triple-I's method of making objects is quite different from the building-blocks approach used by MAGI. "The First thing that happens is that Art Durinski encodes the blueprints of an object using a digitizing tablet. The blueprints have the object made out of polygons. If the object has curves, they are approximated with lots of these little polygons which will be rounded off later. Then — when our program reads that in — each of the polygons will have colors assigned, and the algorithm converts all the vertices of the polygons into the coordinate space. Then, when you've got a lot of polygons in there, the computer has to figure out which ones are in front. It does this in scan-line order — left-to-right, top-to-bottom — and at each scan-line it tries to figure out which one of the polygons, being cut by each point on each line, is in front."

Triple-I commonly uses two methods to round off all those flat polygons into smoothly shaded curved surfaces. "There's Gouraud shading, which will do a linear gradient across the polygon. Then there's Phong shading, which will interpolate a 'normal' across it, and the computer computes the direction where the surface-normal is pointing with respect to the light source and the observer, to get the grey value. If we're working on an object that's got smooth curves like a sphere — and we're making that out of polygons — what we do is we average the polygon normal around a point and come up with a normal for a vertex. Then we use where the observer eye-point is, and where the light sources are [relative to the object] to figure out where the highlights should be."

Thus it is that the object is given form and solidity by virtue of its realistic shading and highlights. That's self-shading, which is quite a different matter from calculating the shadow that the object will cast on the floor or on other objects in the scene. "The shadow casting program was implemented by Frank Crow. First, from the light source's point-of-view, the boundary edges of the object are figured out. From there, it makes invisible polygons that define the volume where the cast shadow is. Then, when you're working on any given point in the picture, if the point being calculated enters that volume and strikes a surface, the computer knows that surface is in shadow. But if it goes through and exits the volume out the other side, it knows that there's no shadow on anything it strikes there.



The completed solar sailer, with its constituent polygonal facets smoothed out and its coloration defined.



A closer view of the solar sailer's bridge.

“As for transparency, when you look at objects in the real world and say, ‘What makes them do that?’ you find out that there are actually several different kinds of transparency. There’s one transparency that is the colored-filter approach, which is when, for instance, you have a blue object and you put a red filter in front of it, you get black. The other type of transparency is like if you have a blue object and you have a red beam of light crossing in front of it — you’re still going to see the blue, but it will be averaged in with the red. It depends on what it is you’re trying to simulate, which may be a combination of both effects.” A good example of the latter type of transparency is the diaphanous sail of *Tron*’s solar sailer.

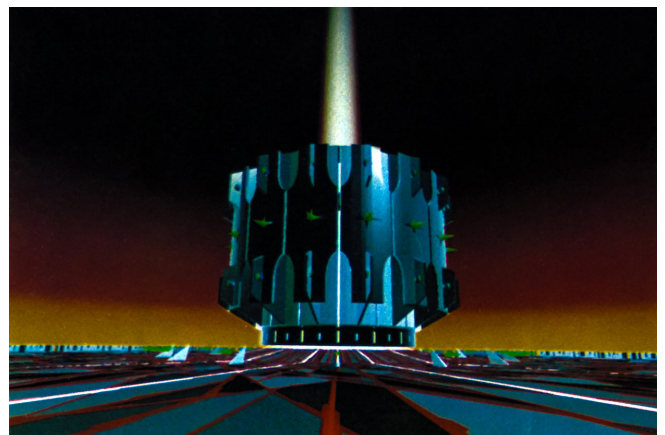
“We’re getting to the point in computer graphics where we can make a lot of things look totally real. We don’t want it to look like it’s done by computer, obviously. We want to reach the point where you cause people to suspend disbelief.” The fact is that Triple-I already has the ability to do that with certain kinds of things, which prompted Dungan to quote Arthur C. Clarke’s third law: “‘Any sufficiently advanced technology is indistinguishable from magic.’ Now — right now — computer graphics is magic. In computer graphics we can do things that are impossible. We can have objects levitate or pass right through one another, and we can have metallic objects interpolating their shapes. You just couldn’t do that any other way, I would say the future in computer graphics is going to be magical; and I think *Tron* is going to be the busting loose point.”

Very important to the visual continuity of *Tron* is the hand-done effects animation, produced under the supervision of Lee Dyer. It seems as though few people outside of the field even know that effects animation exists. When in *Mary Poppins* the skyrocket was spiraling around the magical governess, it was Dyer’s job to paint the sparks and similar effects. The back-lit descendant of that kind of work is what he and his assistants did for *Tron*. Dyer’s previous work with Disney includes *101 Dalmations*, *The Jungle Book* and *Robin Hood*. But when Walt passed away, Dyer left the studio. A recent credit is the character animation he did for the Taarna sequence in *Heavy Metal*. Dyer returned to Disney’s in 1981 and soon became involved with *Tron*.

There are some fifteen minutes of effects animation in *Tron*, but you have to keep your eyes open to see it, because most of the scenes last but an instant. “The effects in this film are very geometrical compared to traditional animation effects. Steven didn’t want anything done that was like anything previous to this picture. That was hard. But I think we’ve achieved it in many ways — like the interactive lights on the characters, for example,

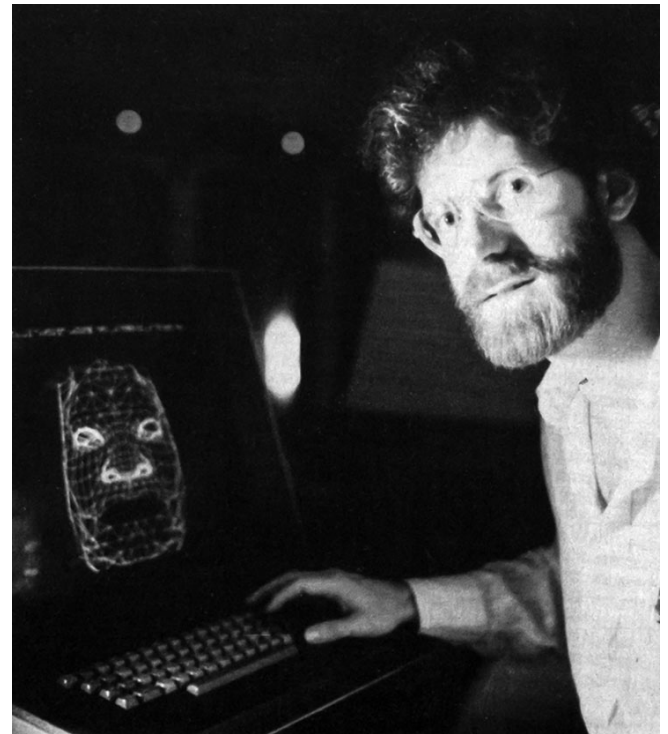


A head-on view of Sark's awesome carrier which pursues the solar sailer commandeered by Flynn and his electronic compatriots.



when the discs are played and so forth. The interactive light we did keeps the bodies from being flat. And we also throw shadows on the floor — for three or four frames maximum — just enough to give dimension to the picture. When *Tron* raises his disc, it looks like there's a lightbulb behind the disc creating the light on his body; and yet, that effect is totally animated.

"The second you see a live-action character in the film, you know the scene is not computer-generated. Flynn is zapped into the computer world using effects animation. Games are happening inside the computer world where they play for life and death — pitting one computer program against another. Flynn is thrown into this, and he is the only real person from the outside. He's the only one there who has emotions like you or I do. The rest of the characters in the electronic world are just programs — but if Flynn gets killed, he'll be dead! There's a love sequence in the picture where *Tron* and Yori go into her apartment, and it transforms from this very drab room into a flowing, liquid type of effect. That, too, is special effects animation. Then she transforms her outfit into a gown, so we had to do the effects around the live-action. We got away from the geometrical look there, and it takes on more of an organic feeling when she changes from one dress to another — sort of on the order of *Cinderella*, with all that pixie-dust.

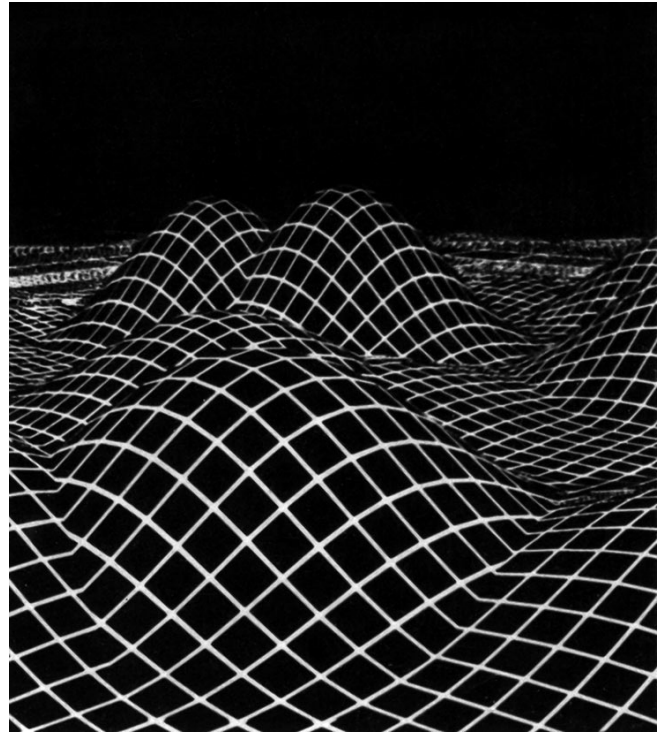


Information International's Larry Malone calls up the face of the master control program on his computer display terminal.

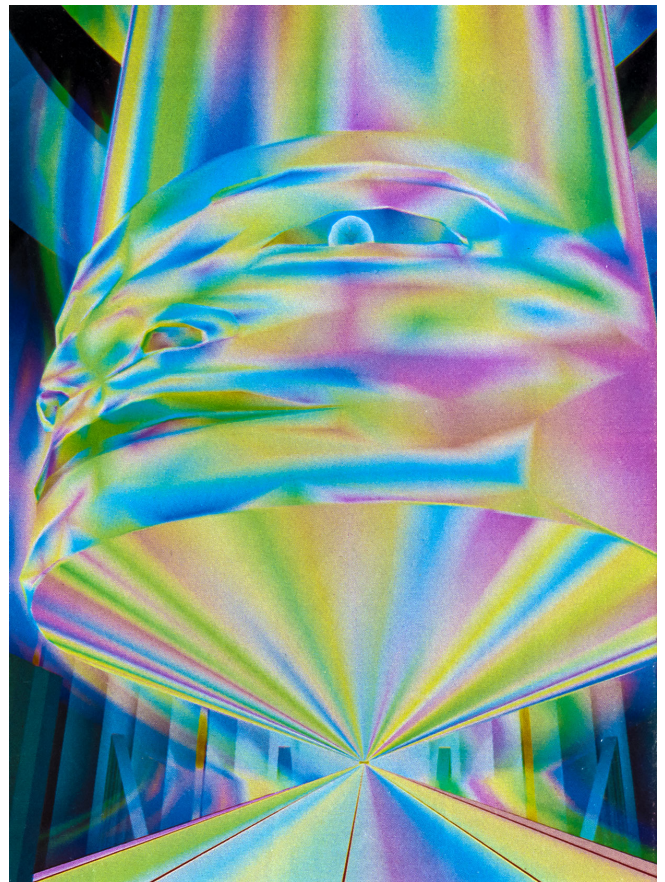
“In the first scenes with the racing light-cycles, there were brief transitional shots where we had to paint the bikes by hand around the live-action characters. Then, with our scene done, the computer animation of the bike race begins. But the nice thing for me about this, is the fact that the animated special effects are so close to the computer animated effects that you can’t tell them apart. When you see them cut together, the marriage is very good — it isn’t distracting to go from one type of animation to the other. It’s the first, I’m sure, that this has ever been done. And even though I’ve been in effects for over twenty-two years, this has really been a learning experience for me.

“I can’t stress how different the film is from any film that any of us has worked on before, from the standpoint of the entire film being bottom lights. If you’re used to top-light animation, it’s very hard to get into the swing of bottom-light.” The difference, of course, is that in top-lit animation the animator paints the colors on the cel and sees those colors right there in front of him as he or she works, while in the back-lit method the animator is creating opaque-and-clear mattes, which the light will come through, and must try to estimate just what the final image will look like after it’s shot through color filters.

Working closely with Lee Dyer were John Norton and his assistant Dave Stephan. Norton was responsible for designing the computer-generated “Bit” character — in association with scene coordinator Deena Burkett — and the Recognizer flying machine generated by MAGI. But most of his work on *Tron* is hand-done cel animation, stylized to look like CGI. Norton has been with Steven Lisberger as long as anybody on the team, going all the way back to the mid-Seventies when they were doing animated commercials at Lisberger’s first studio in Boston. Norton started working on *Tron* in the fall of 1980, about a year after Lisberger began breaking ground for the project. “Dave and I worked closely with John Van Vliet, Chris Casady, Barry Cook, Mike Wolf and



An early vector motion test for the Sea of Simulation over which Sark's carrier pursues the solar sailer. The undulating motion in the final film is somewhat less flamboyant.



the other character animators who were brought in from the outside to work with Lee,” Norton explained.

Per Syd Mead’s design, the MCP was fashioned in the shape of a cylinder — revolving and changing colors as its mood shifted.

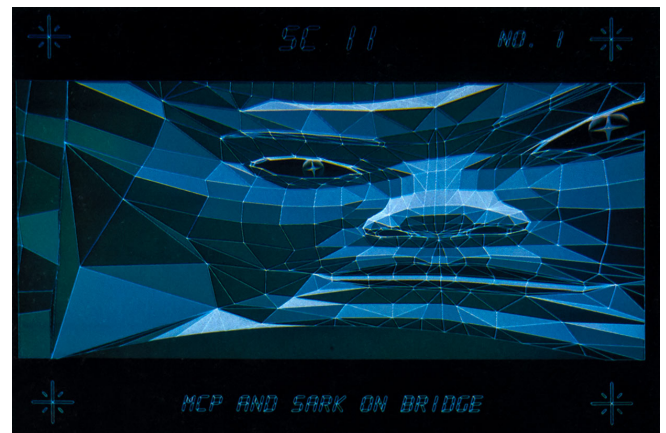
Additionally, Norton designed and animated, by hand, a spider-like mechanical creature called the “grid bug.” “Computer people talk about ‘bugs’ in computer systems, and I always felt that we should do something with bugs for the film. So I came up with this grid creature that lives inside the computer and eats things. Bill worked them into the storyboards, and at first we decided to do them with computer simulation at Triple-I; but it came back to me to do, because they were too busy. So I did about fifteen feet of film that was shot back-lit on the animation stand to try to make it look as much like CGI as possible. The idea was that these creatures camouflage themselves as part of the electronic grid; and then they appear, sort of rising up out of the grid to menace you. First there’s just one who appears, looks around and runs off. Then we cut to a longer shot of a whole herd of these bugs galloping off and out of the scene.”

When all the whiz kids from the land of video commercials arrived at the land of Disney, there was intense culture shock for both sides. To John Scheele, the mighty Disney animation equipment seemed to symbolize the gap that had to be bridged. “The Disney method has come to include little peculiarities that are unique only to itself. The pegs on their cameras are set apart differently from the Acme standard; the field centers are different; the cameras are all just a bit odd from what you see elsewhere. And because this studio is its own world, those little things have never changed and are totally woven into the system. Somebody — and not even Art Cruickshank can remember who’s to blame — tried to draw an inch on the original field chart, and it came out .954 inches instead. That was back in the Thirties; and ever since, that’s been the ‘Disney inch.’ So now Triple-I and MAGI have this strange field chart encoded into their systems, too, and that guy is still getting his way!

“The biggest problem was that Disney’s animation stands hadn’t been updated since *Fantasia*! They have such incredible craftsmen here — nothing is made that won’t last through the ages. The camera stands — especially the multiplanes — are like monuments and memorials to Walt, Ub Iwerks, and everyone who’s worked there. And it’s a shame, on that level, to even mess with them. There’s a real reverence and care for the equipment and physical spaces here, as well as for the people and traditions; and that’s been a special pleasure for me. There’s kind of a mutual attraction that’s gone on — people who’ve known each other and worked together and figured this stuff out, and who’ve been waiting for a chance like this to really put it all together on the screen. It’s a pretty incredible blend of talents and personalities — people who’ve worked at Abel’s, at Gehring’s, on *Star Trek*. It’s the best team that could be brought together for the project. And these areas — the back-lit effects and computer imagery — have never been a part of Disney’s in-house repertoire until now, so we’re really contributing something to the studio. To their credit, Disney recognized the potential of this film and these techniques, and have let a whole new brood inside its walls — one that didn’t work its way up the ladder. That’s caused some inevitable friction. But the studio has always been supportive, and it’s a healthy situation to have some new blood. And we’re obviously excited to be able to work here at Disney, where it all started.”

How well people react to change in their environment has a significant impact on their quality of life. The confrontation between computer generated imagery and the proud tradition of animating

by hand is a fascinating one that has just now heard the bell sound for round one. “It’s like making the adjustment to hyperspace,” said Bill Kroyer. “The big irony is that the older guys like Eric Larson, Frank Thomas, and Ollie Johnston will love this computer generated stuff. They’re ready to see something new happen, and they always have been. The thing about the Disney studio is that the old-time guys were very innovative, because Walt was always demanding of them to move on to new things. They always complained that once they learned how to do something, Walt made them do something totally different on the next film. When you look at the old Disney animated films, the styles change completely from one to the next. We found that the old guys had a real love of innovation and an open-mindedness. But when Walt died that bravery of innovation stalled here at the company. Once he was gone, they tried to stay within the parameters as they were then. The whole mentality was: ‘We do what we do best — which means that we keep doing what we’ve *been* doing.’ But what you ended up with was a situation where you had a whole bunch of young people coming in who knew all about the meaning of animation and what it was trying to achieve and its potential; and they found that they weren’t going to be allowed to innovate at all here, but only to keep repeating what had been done.

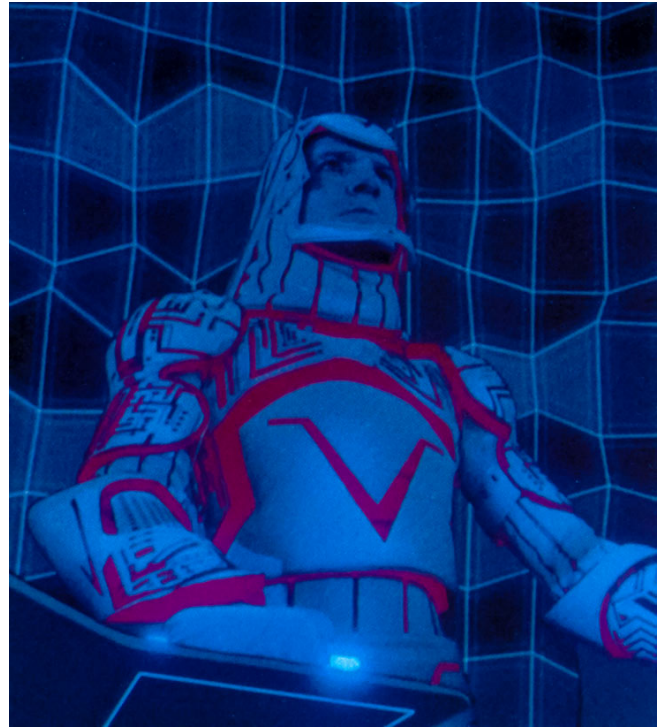


Both Triple-I and MAGI produced computer generated still photographs for use as backgrounds in some of the backlit sequences. While MAGI's generally had to be enlarged from VistaVision format and airbrushed, Triple-I's — which could be played out in a larger 4x5 format — were able to be used without modification. For a sequence in which the MCP — in polygonal facet form — communicates with Sark aboard his carrier, Triple-I generated a series of sixteen slightly different background plates which could be enlarged onto kodalith cels and then alternated from frame to frame, using standard cel animation techniques, to suggest that the character was speaking.

“Jerry Rees and I came here with dreams to do Disney-quality animation, not to *redo* Disney-quality animation. But we found ourselves boxed in until this project came along. Now we are able to apply all the things that the Disney animators have learned over fifty years — that we have inherited from their experience — and show that the entertainment principles that they struggled to learn can be applied to the totally different computer medium. And we feel especially great about the fact that we’re doing it at Disney, and that Disney is the first to benefit.”

Shelley Hinton reflected on the Disney studio’s past — its ups and downs, and where it’s heading: “*Tron* represents a timely turnaround. I have a mental image of the studio after Walt died — with it being left to his cohorts to protect from the vultures and coyotes that could come to pick the place apart. Opportunists might have tried to take advantage of a studio without its founders. So I imagine it was necessary for the survivors to examine the tried and proven elements — the high standards and idealism that had built the Disney legacy — and maintain them as the status quo. This evolved into the ‘Disney Formula’ that’s become so familiar. The flip side of that, though, is that these same guidelines became constraining boundaries.” So a place that had been a Mecca for innovation and creativity appeared to stagnate for a decade or so, and much of the public became disenchanted with the Disney product. But eventually it became obvious that it was impossible to stop the clock. “They’ve been through that period; and now there are new people, new minds, and new ideas to add to a strong foundation. Those who have been here awhile really represent the heart of the studio, and there is a lot to be learned from them. It seems the right time for the combination of old and new. The prevalent attitude at the studio is one of optimism. They’re ready to say: ‘Let’s move forward. We’ve survived the deaths of Walt and Roy and we’re continuing to grow. Let’s take a look at what we’re founded upon and apply it to the present and future.’ Now I’m looking forward to some really progressive new projects here — to being a state-of-the-art company — because that’s what we’re based on.”

The concluding remarks of most *Tron* workers almost inevitably include some thoughts about the promise that the new tools used on the film hold. To the common man, computers have come to symbolize the most dehumanizing aspect of technology — and not without some justification — but these are just tools, not to be blamed for the uses to which they have been put. Only recently



Sark, inside the MCP's communication cylinder, positioned against one of Triple-I's computer generated backgrounds.



Robert Abel and Associates employed their vector graphics system to produce a computerized cityscape for Tron's opening title sequence.

has the public begun to realize that computers can be made to do beautiful things. Coming from the center of the computer graphics explosion, Richard Taylor said philosophically: “I’m continually asked if computers are going to replace people in the arts. A lot of people seem to think of them as a threat. The thing is that computers are not a threat. I think they’re just as evolutionarily natural as a tree. When consciousness evolves into matter, eventually machines are a result of that evolution. The digital watch on your arm is as natural as the flowers in your garden. Apparently, when consciousness evolves, it starts inventing wheels, fire and easier ways to do things. Eventually, it makes machines — and computers are just one of the more recent evolutions.

“Computers are like anything else. It’s the way man uses them. I think a computer is really just an instrument of expression — like an organ or a piano. It’s how you play it that eventually resolves what value it has. They don’t replace people and I don’t think they should be intimidating to people. It takes people to play them; and it takes imaginations to give them value. They certainly aren’t going to replace animators or musicians. They’re just here to help us express ourselves more clearly.”

Steven Lisberger had similar thoughts. “There is this fear people have that eventually actors are going to be replaced by computer characters. I don’t think it is valid at all. The only thing that the technology is going to do is provide the actors with new places to go and new ways to go there. I myself have a fear of technology taking the humanness out of our lives and creating a barrier between people. The notion in the film is that, if anything, the technology should make people more accessible to each other, rather than creating frustrating walls between us. I have a dream that with computers eventually films will become interactive, and that eventually they will be designed where audiences can participate in the picture. Depending on how involved or skilled they are, the audience could actually affect the outcome of the movie. If you had a really hot audience, the good guys would win; if you didn’t, the bad guys would win. The audiences’ reactions would determine which way it went.”

“The nice thing about computer generated animation,” Larry Elin concluded, “is that there’s really no end to the possibilities for it. The technology is literally a fetus. *Tron* is going to be thought of as the maternity ward of computer graphics in entertainment.”

Finally, writer-director Lisberger summed up his feeling on the relationship between himself, Disney and his film: “I do believe in a lot of things that Disney is. They gave me some of the happiest moments of my life when I was a little kid. I used to love their old movies and I feel, personally, that I have a debt to the company for all the good times they gave me. It’s magic-land; it’s true. And I hope that *Tron* brings some of that back. That would be my wildest dream — to capture some of that magic again.”

Tron photographs copyright © 1982 by Walt Disney Productions. World rights reserved. Special thanks to Michael Bonifer and Hilary Clark.

silent running

article by

Pamela Duncan

Douglas Trumbull's name is widely recognized in today's high-technology film world. But that was hardly the case back in 1972, when Trumbull, then 29, brought *Silent Running* to the screen. The Universal release, regarded by many now as a classic, marked his first attempt to write and direct a feature film. At the time, the bulk of Trumbull's reputation and experience had derived from the three years he had worked with Stanley Kubrick in London on *2001: A Space Odyssey*. A major

contributor to many of the special effects in that film, Trumbull had, among other things, invented the slitscan machine for the Stargate sequence at the end, the dazzling results of which led to the movie being unofficially subtitled "the ultimate trip." Following *2001*, he returned to the Los Angeles area and set up Trumbull Productions in Canoga Park, where he created the special effects for numerous television commercials as well as *The Andromeda Strain* and films for NASA. During this time, Trumbull discovered that his unique experience with Kubrick had left several deep impressions.

"I was still very young when I finished *2001*, and in many ways I felt that I'd just gotten out of school, because *2001* was the greatest educational experience anybody like me could ever hope to get. We had no budget and no deadline and we could do anything we wanted. So, for a few of the years after *2001*, I tried on my own to recreate the environment that I'd had on that film by doing a lot of experimentation and applying it to television commercials and small projects. But ultimately I found out that I simply couldn't afford it. There is just no place in the bulk of the movie industry that will allow you to expend the amount of time and energy fooling around, as we did on *2001*, to discover something new. The studios just want it now; they want it off the shelf; and they want it at a low price. It nearly killed me, financially. But it was through television commercials and having done *2001* that I finally pulled together the deal to do *Silent Running*. It happened through a meeting with Mike Gruskoff, who at that time was the agent of a friend of mine. He was very interested in me, and in trying to do something unusual. So we started throwing around ideas for making a film; and after a number of talks, I ended up writing about a ten-page treatment for *Silent Running*." Gruskoff was sufficiently impressed with Trumbull's treatment to submit it to Universal, along with several conceptual illustrations rendered by artist Don Moore. Universal agreed to do the film as part of a new program the studio happened to be developing.

"We were just at the right place at the right time," Trumbull elaborated, "because Universal was going into about a five-picture low-budget crap shoot to try making a number of inexpensive pictures with absolutely no holds on the director or producer. The studio didn't see the film. We had final cut. We had total control. It was an experiment, really, on their part, to see if they could come



up with another hit like *Easy Rider*. And so we were lucky to get in on the program — we were allowed to make the film with absolutely no controls, and with no intervention on the part of the studio. It was a fantastic opportunity.” Universal offered the role of producer to Gruskoff, who accepted the job.

Curiously, Trumbull’s original ten-page treatment bore almost no resemblance to the final script. “The whole story revolved around this one man who’s out on a space freighter all alone, assisted by something like two hundred robots who do all the work. He’s kind of like a sea captain hauling cargo from one place to another, but his real dream is to go out and explore the distant universe — way out beyond the normally traveled routes. So when he learns that they’re going to junk his ship and retire him, he sort of freaks out and decides to seize this grand opportunity to just split. And the whole *Silent Running* concept, therefore, was analogous to a submarine diversionary tactic in that he goes through these complex maneuvers to escape detection. First he modifies the robots and gets them to paint the outside of his spaceship black so it’s not even visible. Then they knock down every antenna and every electrical device and send it out into space, so there are no radio emissions coming off the ship at all. And they also leave a trail of debris as though there was some big explosion or some horrible thing went wrong. Then, after doing everything he can to make himself as hard to detect as possible, he sets off alone on this crazy trip. He takes pictures of himself with the robots, and he programs them to be his friends, and they’re all having a great time. And he’s always putting notes in bottles and throwing them out into space — crazy things.

“But the gist of the story was that by virtue of the fact that this one man, all alone, cuts himself off so severely from the rest of mankind and society, apparently — and you never really quite understand why — an extraterrestrial craft seeks him out. Basically the idea was that because this one man was no longer contactable and no longer involved with human civilization, he *becomes* contactable by others. Anyway, he thinks this alien craft is the cops coming to catch up with him, and he turns off *everything* in the ship — even the air conditioning and his air supply — and he watches this thing approach him for several days. But by the time it finally docks, he’s unconscious from lack of oxygen. The extraterrestrials enter his ship and they probe him and they probe his ship and they see everything that’s going on. It was going to be a very spooky, hair-raising sequence. And then they leave; but by now they’ve realized what he needs and they turn his air back on for him and fix everything up. After they’ve gone, the guy regains consciousness and realizes what’s happened. Then, after a while, he notices that one of the robots is missing and tries to make contact with it. Somehow, it has inadvertently climbed across onto the outer body of the alien ship and is now sending back radio images. The guy manages to maneuver his robot by remote control, probing the exterior and then finally the interior of this alien craft. But just as he is about to make contact — via remote control — with this other civilization, the cops *do* catch up with him. And there’s this big tense thing at the end. He realizes that it’s all over and he’s never going to get this chance again, and so he tries to keep the cops off, diverting them with all kinds of things while he continues to try and make this incredible contact. At the end, he finally does get killed, right in the midst of everything, and in the final scenes of the movie, his robot actually meets the extraterrestrials. And the robot, not knowing what the hell to do, pulls out one of these photographs the guy’s been taking all the time — a strange sort of family portrait of a man and three robots — and shows it to the

extraterrestrials. The whole thing was very, very strange. And obviously, it had little to do, really, with what the movie finally became.”

Instead, what it became was a film about ecology. Set sometime in the 21st century, *Silent Running* raises the spectre of the total defoliation of the earth. When the movie opens, the last remaining forests have been placed inside geodesic domes and carried into space. There, they are to be maintained on freighterlike spaceships until the earth is sufficiently unpolluted to support plant life once again. The only person who still cares to see that happen, however, is Freeman Lowell (played by Bruce Dern, in his first non-heavy role), a botanist who has tended the spaceship *Valley Forge* for eight years. Accompanying him are three fellow astronauts — young men serving shorter tours of duty aboard the ship, who are obviously unimpressed with the wonders of nature.

This feeling, apparently, is shared by those in charge on earth. Orders come to nuclear destruct the forests and return home. The astronauts eagerly begin to obey the command, but Lowell becomes desperate to preserve the forests. He attempts to block the efforts of one astronaut to set a nuclear bomb in place; and in the ensuing fight, the astronaut is killed. Having gone this far, Lowell decides to spare nothing to save his forests. While the two remaining astronauts are placing more bombs in another dome, Lowell traps them inside and blasts the dome off into space, where it explodes. Then, making the other nearby freighters believe that the *Valley Forge* is hopelessly crippled, he pirates the ship and moves out beyond Saturn. Now he is alone — his only companions are three little robots, or drones, whose function it had been to maintain the ship. Driven by loneliness and guilt, Lowell reprograms them to be his friends. From there, the film becomes the story of his relationship with the drones and his rapid mental deterioration.

Obviously, a major transformation took place from the original treatment to the ultimate script. Most of the key elements of Trumbull’s first conception were altered, or eliminated altogether. Notably, the main



Douglas Trumbull made his directorial debut with the 1972 production of *Silent Running*, doubling up as writer and visual effects supervisor in the process and producing a remarkably rich-looking film for a minimal \$1.3 million.



In his first starring role, Bruce Dern played Freeman Lowell, a dedicated botanist charged with caring for the

character was no longer alone and an element of conflict had been added; the robots' numbers had been reduced from two hundred to three; and the submarine analogy had been minimized. for the most part, the changes were due to the successive assignment of three new writers — Deric Washburn, Mike Cimino and Steve Bochco.

“According to present day movie making,” Trumbull lamented, “you simply cannot survive if you make what they call a ‘soft’ film. You can’t have a film with a sweet storyline, where somebody doesn’t get killed or shot or chased after or something. So right off the bat, there was an injection of other people into the story to give Lowell somebody to fight against. And right away, he’s knocking off people and having a big conflict with the other crew members. I was really sort of run over by a lot of dramatists and screenwriters.”

Producer Michael Gruskoff maintained that the changes were other than artistically motivated. “The problems with the original script were financial. Universal only gave us a million dollars, so we had to jettison a lot of Trumbull’s script just to allow us to make the film.” There were several potentially expensive features of the movie that Trumbull had conceived, not the least of which were the requirements for extraterrestrials and two hundred robots.

For the sake of economics as well as dramatic impact, then, the script was revised again and again. “No three writers ever worked simultaneously,” Trumbull remembered. “It was always one writer rewriting another writer. We went through a number of different scripts and never really accurately captured the concept that I was after. Then finally I rewrote *all* of them, compositing the good elements from a number of writers and rewriting three quarters of the script myself. But I never got screen credit, because I wasn’t a member of the Writers Guild. I had a huge arbitration with the Writers Guild, and proved that I had written three quarters of the script myself; but I still couldn’t get credit. It was an unfortunate experience.”

spaceborne remnants of earth's pollution decimated. ~~As a byproduct of the original script, Trumbull had prepared a series of shirts with the words "Suburbs"~~ Trumbull and producer Michael Gruskoff used to help sell the project to Universal.



Freeman Lowell at the master controls of the Valley forge. Trumbull conceived of the idea of using a decommissioned aircraft carrier and refitting it for the space freighter interiors.



The aircraft carrier's Combat Information Center as it was before art director Wayne Smith and a crew of shirtsleeve industrial designers began work on it.



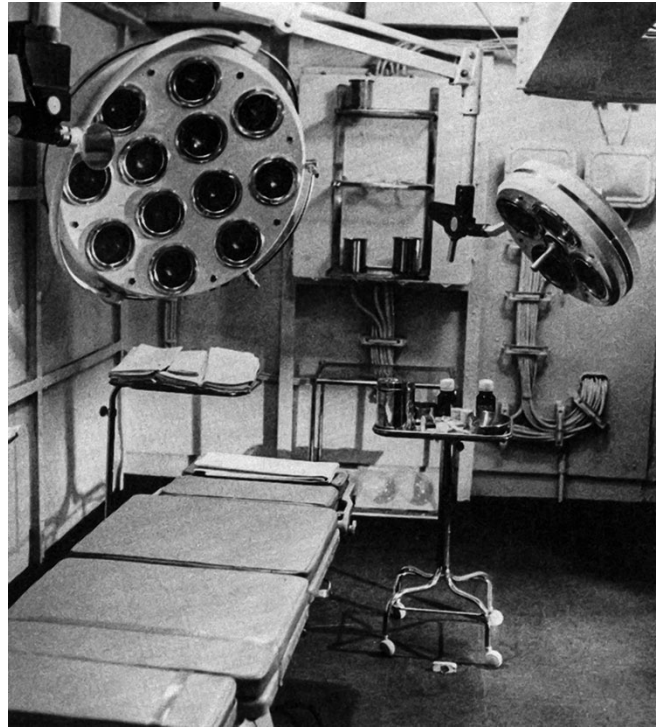
The finished set from approximately the same angle. Every effort was made to retain as much of the original

Nevertheless, while the script continued to gyrate, Trumbull accelerated into preproduction. At the time, his crew consisted primarily of Richard Yuricich and Richard Alexander — both fellow veterans of 2001 — as well as John Dykstra, Wayne Smith, James Dow, John Baumbach, Bob Shepherd and Bill Shourt, all recent graduates of the industrial design department at California State University — Long Beach, who had already begun gravitating to Trumbull Productions prior to *Silent Running*. To a man, they were young, generally inexperienced, but tremendously enthusiastic and gifted.

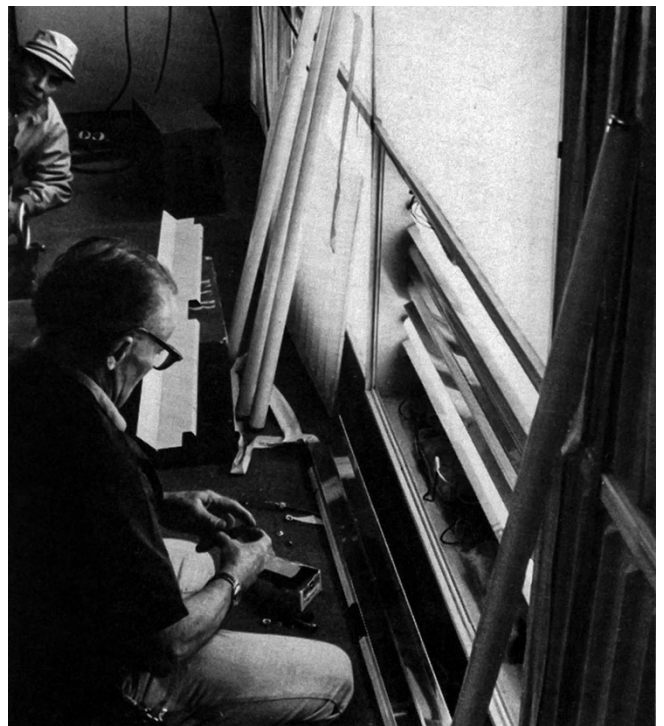
ship as possible, with exposed cables, ducting and other artifacts that suggested a true working environment and restructured in plywood and vacuum-formed styrene, rather than an slickly-designed film set.

Douglas Trumbull had a definite philosophy on the “look” of the film. “What I wanted was actually a reaction against 2001, where everything was pristine and clear and white and ‘designed.’ I wanted to have a look that was extremely functional, with everything exposed — which is really much more the way actual spacecraft are. And I just came up with this idea of using a Navy ship for the spaceship interiors. We looked at several, and finally decided that an old aircraft carrier would be ideal. It had properly designed areas that we could use as sets; it had a huge hangar deck that we could fill with cargo; and it was loaded with strange-shaped doors and bulkheads and a lot of steel and open ducting and wiring and strange switches and controls. It was terrific, and we really saved an enormous amount of money by using it.”

The ship chosen for *Silent Running*’s primary location was the USS Valley Forge, a decommissioned vessel waiting to be scrapped at the Long Beach Naval Station. An attack aircraft carrier of the ESSEX(CV-9) class, the *Valley Forge* was commissioned on November 3, 1946. From her decks had been launched the first carrier air strike of the Korean conflict, and she had subsequently served extensively both in that war and in the conflict in Vietnam. The *Valley Forge* made her final return to Long Beach in late 1969, and was formally decommissioned the following year. “We rented the aircraft carrier on a monthly basis,” Trumbull explained, “and paid for services from the Navy base. We also hired, full-time, Winfield Chitister, a chief officer who had just retired and knew the ins and outs of the base. He went on our payroll to interface between our crew and the Navy, so that we could get on and off the base, and get passes and security patrols and all the kinds of things that we needed.”



The Valley Forge medical bay.

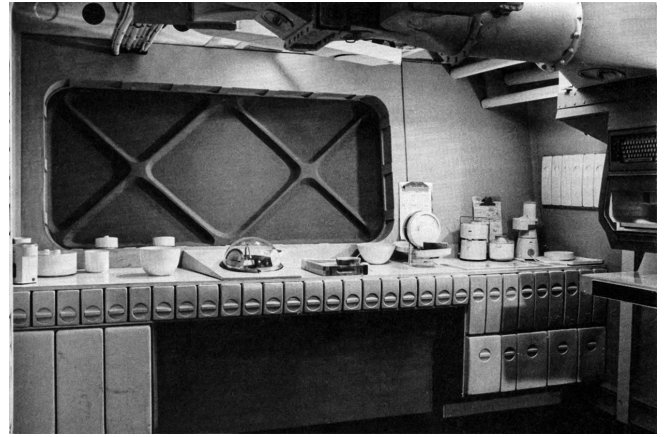


Effects technician Richard O. Helmer wires up a wall of fluorescent lighting, installed in the recreation room to provide a more cheerful and relaxed environment for the crew's off-duty activities.

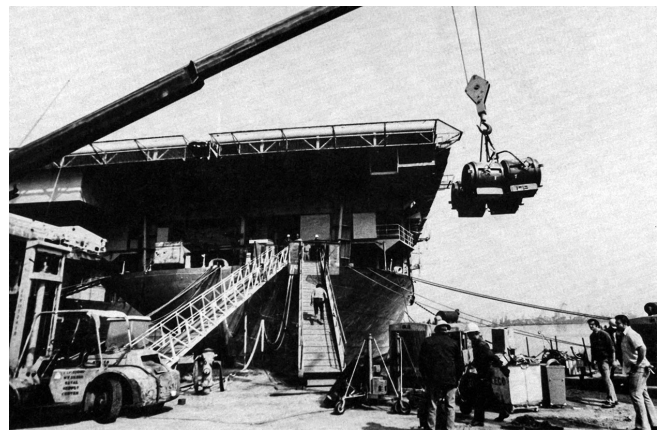
The principal part of the aircraft carrier that was chosen for shooting was the Combat Information Center — or CIC. Wayne Smith was in charge of the modifications that were made there. “Originally we were going to use a lot more of the ship. We were going to go down into the engine rooms and do all kinds of things, but it was too big of a production — it was like a major location change, just going from one deck to another. So all the shooting was done on the CIC and hangar decks. The Combat Information Center was the best area logistically, although it proved to be difficult at best. To get there, we had to come up to the ship and then walk up a gangplank onto the hangar deck. About five hundred feet down the hangar deck, there was a set of ladders that went up thirty feet to the area where we were. It was a kind of a war room area, sandwiched between the hangar and the flight decks. It was very small and very tight. We wanted that claustrophobic look, but it was difficult moving around and getting our gear up and down those steep ladders. There was no power on the ship, no water, and no heat. We had power generators on the dock, with cables running from there up to the shooting area. The generators were subject to occasional failure — fuses sometimes blew from overloads or were absent altogether, requiring a lengthy job of tracking down circuits. And believe me, there’s nothing darker than the inside of a ship — or spookier, with all the creaking and strange noises.”

“It was a totally believable environment, working on that ship,” Jim Dow remembered, “because it wasn’t a three-wall set. You were in this tremendous thing, eleven hundred feet long. It took quite a bit to get up to the area where we were shooting, and by the time you worked your way up into the Combat Information Center, you could almost talk yourself into believing the whole spaceship thing.”

Even though the *USS Valley Forge* possessed both the atmosphere and the “look” that Trumbull wanted, a good deal of modification was required. “The doorways were oval,” Trumbull explained, “so that you had to step up about a foot. They were built that way so that if water came in in high seas or something, it wouldn’t slosh from one room to the next. Well, obviously that didn’t apply to an outer space environment, so we ended up torching out all of the doorways and building in new ones out of plywood and vacuum-formed styrene. We could break up or destroy anything on the ship that we wanted as long as we didn’t physically remove any metal, because it was simply up for



Incorporated into the kitchen set was a large window which slid down — since there was no room for it to slide up or to the sides — to reveal the starry expanse of space. In actuality, the window was almost flush with the ship’s bulkhead, with a front projection screen mounted directly behind the opening so a moving star background could be inserted during principal photography.



A large industrial crane was needed to hoist brute arcs and other heavy equipment up onto the aircraft carrier’s hangar deck.

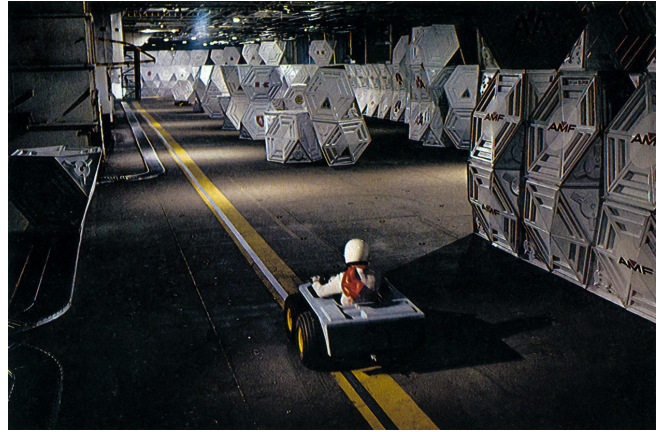
sale as scrap metal at the time. So we did a lot of physical torching out of things and putting in vacuum-formed shapes that we would make and then screw or glue to the wall and paint. For props, we brought in a few little tables and chairs and things. Also, we made a couple of huge walls of fluorescent light fixtures to break up the lighting effects. Each room in that deck had something that we wanted to use. The control room that we used was the actual communications center of the aircraft carrier. All of the flight operations had been controlled from there, and there were radar screens and consoles and all kinds of things that we modified. And there was another small room that I wanted to use as the medical bay which had a terrific big duct that was naturally there and looked great — a really neat, functional-looking piece of equipment.”

“The doorways were made of something like half-inch steel boiler plate,” Jim Dow elaborated. “We hired one of our friends from school, who was a sculptor. We brought him in with an acetylene tank and an oxygen bottle and a cutting torch, and he sat there for weeks cutting these arches out an inch at a time — just cutting through this half-inch steel. In the control room — underneath where we put the video monitors — there was a giant, solid steel, immovable panel. We had to build the monitor boards from plywood and plastic, and set them over the existing Navy control module. All of these things had to be hooked up and working. The rest of the additions to that room were just backlit plexiglass and touch switches — pretty primitive stuff, when you look back on it now.”

Overall, the basic concept behind the modifications was that the control room represented the workaday world, and therefore was left with chunks of hardware visible to the camera, while the kitchen and recreation room were supposed to be more cheerful — effected by light changes and the predominance of white on the sets.

The cargo hold sequences were filmed on the huge hangar deck of the aircraft carrier. The primary change there was the addition of about a hundred and fifty four-foot-high truncated tetrahedron cargo canisters, which were used as set dressing. “That space was so big down there, it gobbled everything up,” Wayne Smith explained. “We kept putting in more and more stuff and it just disappeared.”

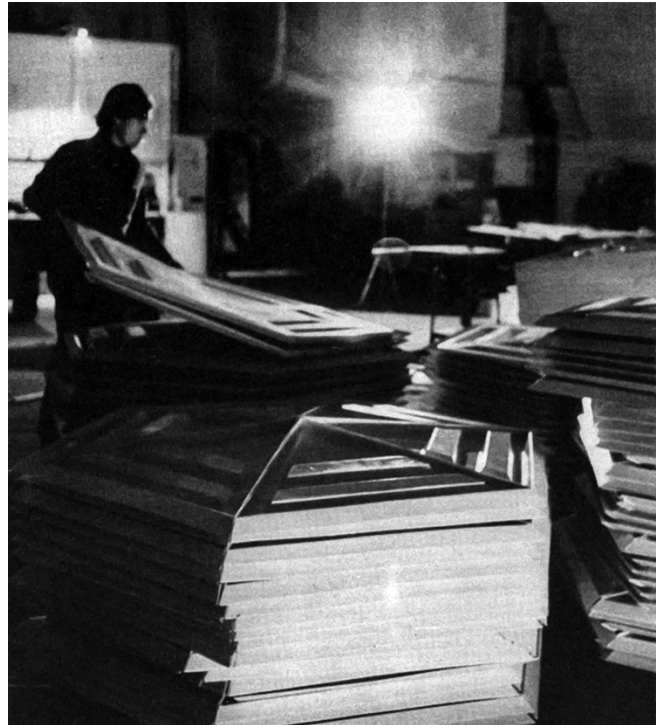
Jim Dow recalled the magnitude of the job of creating the canisters. “I think there were something like two thousand pieces. We made the patterns in wood, and did the aluminum molds for the pie-shaped piece and the triangular keypiece. Then we sent the patterns out and had the pieces vacuum-formed on a large machine. They came back to us with something like a six-inch flange on them that had to be cut off. The stuff was about an eighth of an inch thick, and it just made a horrendous noise when it was being sawed. But we went down there — six of us — with pop rivets and band saws and sawed them out, pop riveted them together, and filled the hangar bay with those things. We were all deaf by the time we finished.”



With only slight modification, the hangar deck became a vast cargo hold for the Valley Forge.



In order to help fill the massive space, a four-foot-high cargo canister prototype was designed in pieces and then farmed out to be vacuum-formed in quantity from high-impact polystyrene.



Bob Shepherd assembles one of the canisters using clamps and pop rivets. A crew of six spent several days on the carrier's hangar deck assembling and placing some one hundred and fifty of the containers.



Between shots on the garden set, constructed in a vacant hangar at the Van Nuys airport.

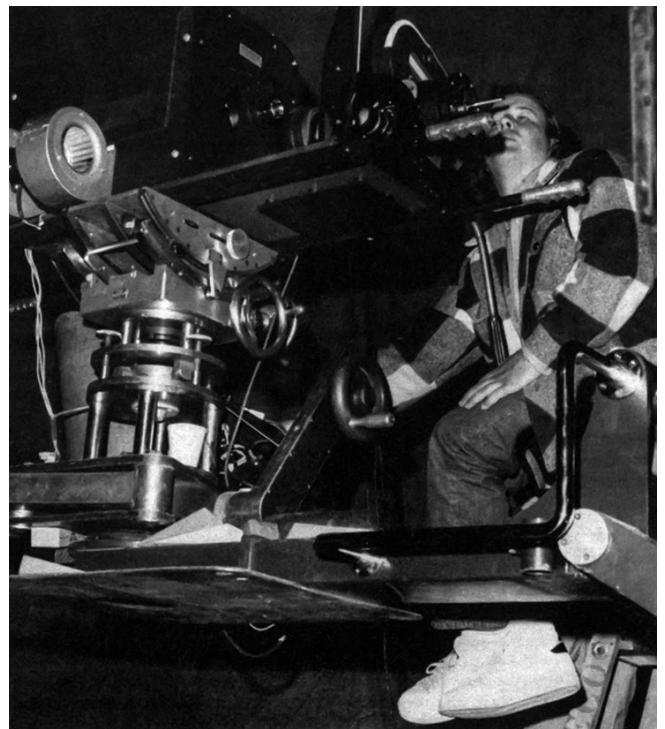
Vacuum-formed plastic was widely used in the modification of the *Valley Forge*. “I think we were probably the first people to use that in the film business,” said Bill Shourt. “It’s a pretty simple process, really. First, you make a wooden mold that has relief on it, so you can draw the plastic down over it. Then you take a sheet of styrene or ABS and heat it up so that it gets almost ready to melt. It’s on a big platen; and when the thing gets hot, you drop it down to a big vacuum tank, and that just sucks the piece of plastic all the way around the mold. Then, when it cools, you cut it off and trim it to shape.” Although Trumbull Productions possessed a vacuum former, it was relatively small. So while some of the smaller shapes — detail for the corridors, for example — could be made in-house, most of the vacuum forming had to be farmed out.

The aircraft carrier set design was done largely on the spot. Very few drawings were even made. “We just shot right past that stage,” said Wayne Smith. “Because most of the guys we were working with had some design experience, they would work stuff out on their own. It was really a collaborative effort, between Doug and the guys that were working with me. We would propose ideas on how to cut things out or what we wanted to do, and he’d either say it looked good or it didn’t look good. We tried to use the ship as much as possible — we just wanted to change it a little bit. It was mainly a matter of taking out the stuff that was obviously nautical. We didn’t want to destroy all of the hardware that was hanging in there.”

It took about fifteen people between four and five months to ready the aircraft carrier for shooting. As the modifications progressed, the atmosphere of the *Valley Forge* began to play some disturbing tricks on the crew. “We were working day and night on this sucker,” John Dykstra related, “round the clock. Now, this is a bunch of college kids, on an aircraft carrier, running it all. The Navy guys, of course, had primed us with ghost stories — we were a bunch of landlubbers, and they were going to feed it to us.

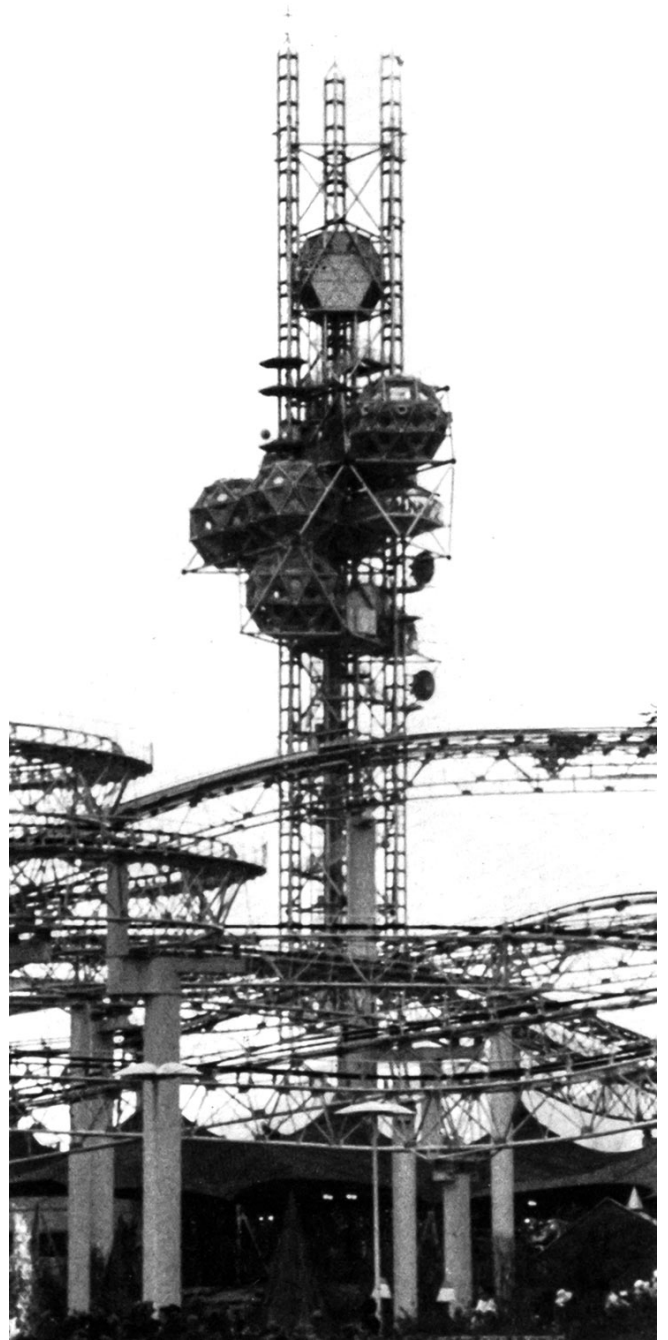


By positioning a rolling Scotchlite screen behind the area of action, the faceted dome surface and stars beyond could be front-projected into the scenes, creating the illusion of a much more expansive playing area.



*Doug Trumbull lines up a front projection shot in the hangar. Unlike most comparable units at the time, the lightweight front projector built especially for *Silent Running* could be carried by one person and mounted on a camera boom.*

After we'd worked there for a while, strange things started happening. The lights would go out every now and then; and everything buzzed, and everything creaked — that boat was very, very strange. One time, one of the guys went out to the rail, which is along one side of the hangar deck. When he turned around to come back, he heard somebody coming down the hallway and decided that he was going to hide behind the bulkhead and scare them. So he did, and the footsteps went by and there was nobody there! He came back very serious about the ship being haunted. From then on, we didn't want to get caught in there in the dark. At the end of the day, we'd start walking out — and you couldn't walk for more than twenty feet without climbing a ladder and making a turn and going down another ladder. Pretty soon, it wasn't a walk any more — we were all going at a good clip to see who was going to get out that door and get off that ship. I remember working in there one night, and the lights went out. I started crawling down the hallway on my hands and knees because there were bulkheads everywhere and I couldn't even see my hand in front of my face — it was pitch black. So I was crawling around on the floor, and all of a sudden all of my bugaboos came to me. I swear to God, that was the last time I worked on that ship alone at night."



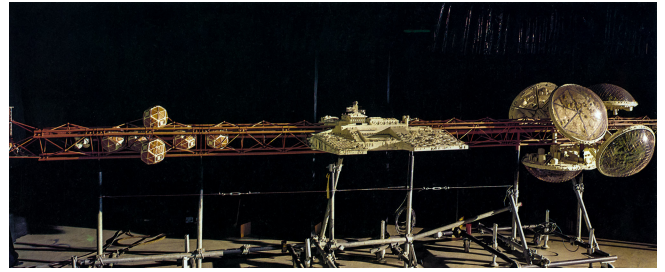
The basic shape of the Valley Forge — a spindly space frame structure with a series of geodesic domes — was inspired by the Expo Tower at the 1970 World's Fair in Japan.

At the same time the work on the aircraft carrier was going on, Trumbull and his crew were building sets in an airplane hangar at Van Nuys Airport. For the dome interiors, a round set, thirty-five feet in diameter, was created by set decorator Francisco Lombardo. Sections of it represented the various domes with their differing types of vegetation — from a tropical jungle to a pine forest to a desert. In addition, a small set was built to represent a section of the spacecraft exterior for the scenes where the drones are shown moving along the outer surface of the ship. Both sets would later be augmented with additional imagery provided via front projection. The spacecraft exterior would be linked to photographic projections of the overall *Valley Forge* miniature, and the garden settings would be opened up with projections of the dome infrastructure.

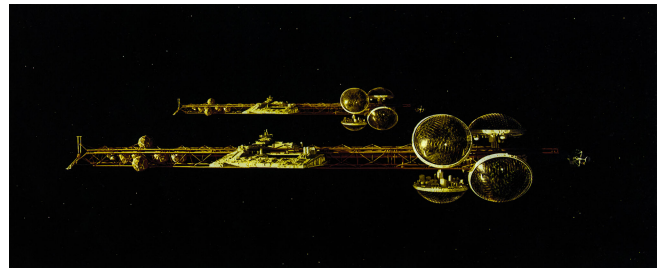
“We had a twenty-by-forty-foot rolling process screen that we could roll to any position around the garden set to film the various domes,” Trumbull recalled. “And we had this 4×5 front projection machine that projected an image of the domed ceiling, with stars and sometimes Saturn outside, as a still photograph. To make the plates, we had to build about an eight-foot diameter model of a dome and photograph it from the inside, to include all the lighting effects and struts.”

Although the technique was not particularly new at the time *Silent Running* was made — 2001 had been the first broadly accepted application of it — Trumbull’s front projection machine was novel in its portability. Despite its small size, the unit had a projection throw of forty to sixty feet, utilizing only a thousand-watt bulb. Made to Trumbull’s specifications by Howard Pearson of Pearson Photographics, it weighed only a hundred and fifty pounds and could be mounted on a boom. At a time when comparable units required a forklift, the machine for *Silent Running* could be carried by one person. John Dykstra, in fact, who performed much of the miniature photography, found himself carrying the unit from place to place with great regularity. “It worked very well,” Dykstra said, “even on that big screen. We were able to shoot at f/2.8 or f/3.5 for all those interiors of the garden domes.”

The remaining preproduction work was done at Trumbull Productions. There, the miniatures were built and the special effects produced. A great deal of activity at the shop revolved around the *Valley Forge* miniature which had to be completed early since the front projection plates featuring it needed to be generated before principal photography could begin. Again, Trumbull had a definite idea of how the ship should look. “The long superstructure of it was designed after a structure called the Expo Tower at the 1970 World’s fair in Osaka, Japan. It was a really neat sort of space frame structure with a cluster of modules on it, very much like what we used in the picture. Wayne

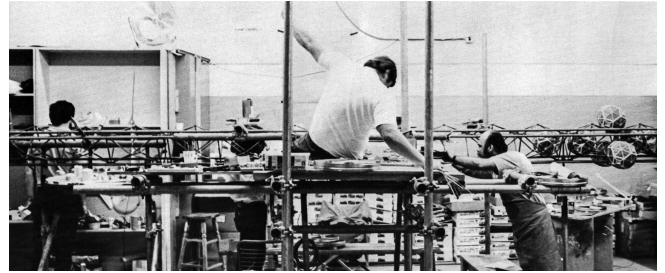


The top of the building, at its most basic, became the tail of the ship, with a cluster of six large domes incorporated onto the opposite end to house the forests.

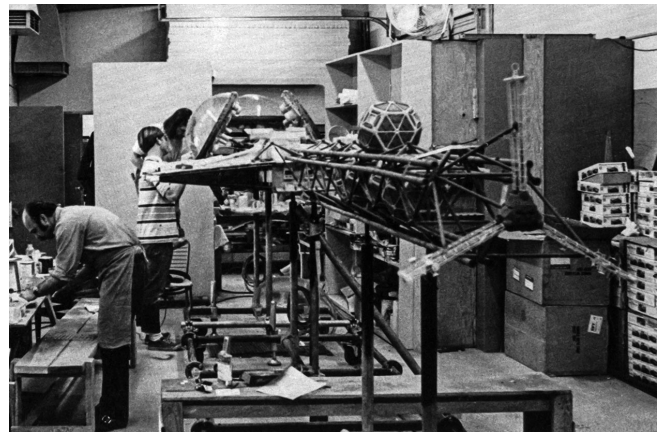


Although several shots showed as many as three of the gigantic space freighters at a time, only one ship was constructed. Other ships were added via front projection, using plates derived from still photographs, cut out and composited together against star backgrounds.

Smith went with me to Osaka, and we climbed all over that thing and photographed it from every angle.” The tower was over three hundred feet tall, and suggested the open, spidery, linear look that Trumbull wanted.



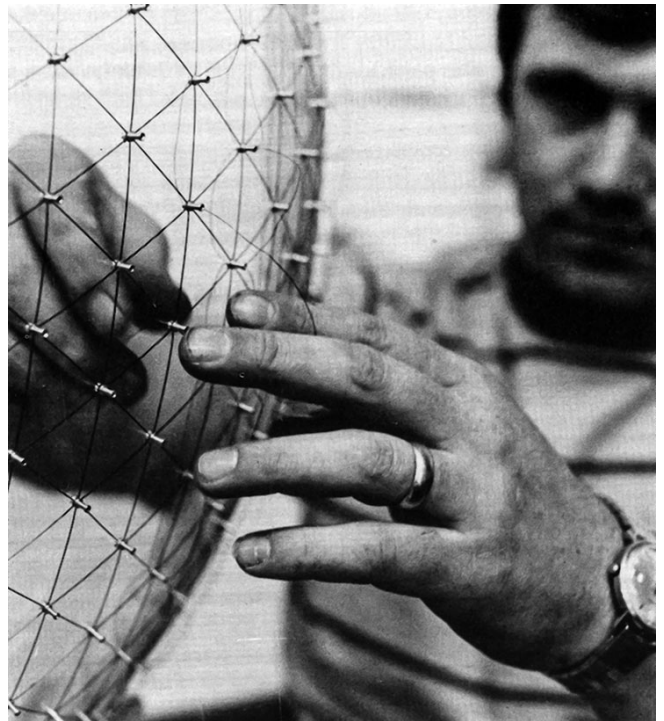
John Baumbach (right) and a crew of model builders spent six months creating the Valley forge miniature. Built in three sections on a rolling carriage, the ship had as its basis a superstructure constructed largely from two-and-a-half-inch steel pipe.



Plexiglass domes for the forest modules were fitted onto six dome platforms constructed at the front of the ship.



The wing area, constructed from wood and steel, was covered with thousands of cast triangular segments and detailed with bits and pieces from some eight hundred plastic model kits.



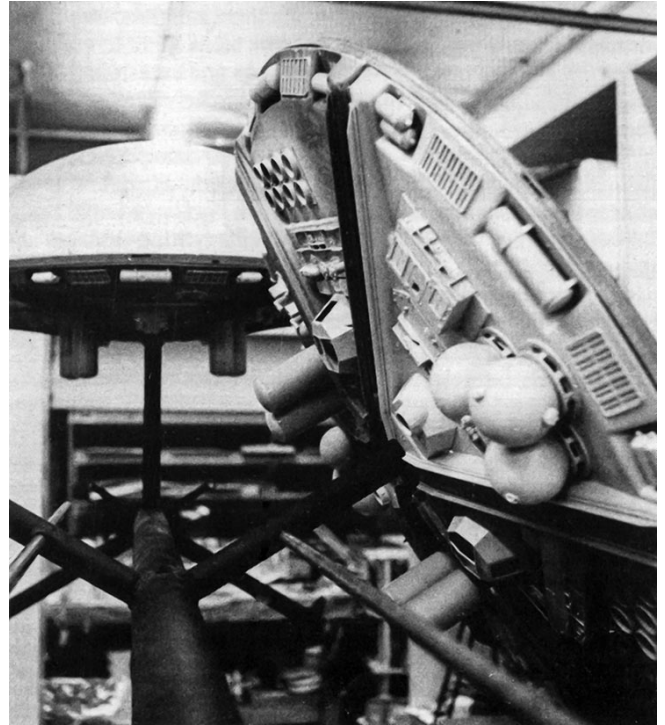
Leland McLemore was responsible for the painstaking task of drilling the plexiglass domes with a matrix of holes, filling each with a standoff insulator, and then threading them all with thin copper wire.

Back in the United States, the tower photographs were turned over to John Dykstra. He and several others worked together to modify the basic design and transform the concept into a space freighter. “The basic shape always had the six domes on the nose, and always used a triangular format. The theme was geodesic throughout all of it. I really liked that ship. I think it turned out a hundred times better than the ship they did for *The Black Hole* — and it was just as filigreed, really.”

An interesting feature of the *Valley Forge* was that it had no visible means of propulsion. This was actually Trumbull’s idea. “The picture was abstract in that I never wanted to deal with what I think is just a lot of junk — that is, the connectives, like what kind of propulsive force the spacecraft has. So many pictures are just filled with those kinds of connectives. But I just felt all that was of no dramatic importance whatsoever — how fast that ship went or how long it took to get from one place to another. So I chose to ignore that problem altogether.”

The spacecraft model was twenty-six feet long, and was built primarily under the supervision of John Baumbach. It was pieced together in three sections on a rolling platform. Two-and-a-half-inch steel pipe was bolted together to make the basic armature, and the wing was made of wood and steel and covered with plastic. For the remaining structure, metal, wood and plastic prototypes were constructed, out of which rubber molds were made, cast in an epoxy resin, and finally painted. “All of the two-by-two triangular pieces were individually made,” Jim Dow remembered. “We had literally thousands of those that had to be cast, cleaned, painted, and then individually applied to the ship. We could make those things now extremely inexpensively, rapidly and cleanly. But that was ten years ago, and we had all kinds of problems — we had air bubble problems, and the silastic rubber molds were breaking down. So there was a tremendous amount of handwork in those that we wouldn’t have today.”

It was necessary to apply a good deal of detail to the surface of the miniature, to render the functional, realistic look desired for the *Valley Forge* freighter. The detailing was taken largely from some eight hundred Japanese model kits, with appropriate pieces cut, sanded, and glued onto the ship. “We called it ‘Shake ‘n Bake,’” Dykstra quipped. “You dip the thing in glue and roll it in model mulch, and see what you get. God, the time that went into that. We did all this research and found this great glue — one of the first hot glues. The only problem was that it aged. The coefficient of expansion was such that I would heat the glue up, and then cool it down; and then heat it up, and cool it down again. Pretty soon, things would be falling off. We’d have a thirty-second shot where the ship would be going by — and, of course, the exposures were very slow — and you’d see this certain part on it in one frame; and then in the next frame, it would just disappear.”



The underside of one of the uncompleted domes.

Unfortunately for Richard Alexander, the glue worked well enough for short periods of time. “I was at the shop one Sunday afternoon, gluing little parts on the model, and Dykstra was telling me what to do: ‘Just glue it on here, okay? And hold it.’ Then he disappeared and I promptly glued my hand to the model. I stood there like an idiot for about an hour trying to drag this twenty-six-foot-long spaceship down toward the phone. It was very embarrassing.” Bill Shourt finally came in and set him free by applying acetone.

Probably the most tedious job involved in the model construction was the creation of the twenty-five-inch forest domes. “We had blown plexiglass domes made,” Trumbull said, “and drilled a matrix of holes in them. Then we inserted little standoff insulators for integrated circuits that had holes in the middle, and you could weave from one to the next with thin copper wires — like sewing — to produce all the grids that made up the geodesic structure.” For Leland McLemore, the job required literally months of sitting in front of a drill press and then threading the wire through the matrices of holes.

Although the model was built on casters for mobility during shooting, the intricate detailing rendered the final spacecraft so fragile and unwieldy that it could not be moved. “You couldn’t touch it,” Dykstra recalled. “You couldn’t even be around the damn thing. It was a nightmare. Miniature trees would fall down inside the domes and you couldn’t get inside to fix them, so there’d be these little trees lying against the side of the dome — zero gravity trees. God, what a headache. That model fell to disarray one day after the film was finished. Doug and Wayne Smith and myself were out there, and we decided we would disassemble it and save the pieces. We started at one end, very carefully removing parts. By the time we got to the other end, it was a slugfest to see who could hit each other with the parts off the thing.” The model had taken six months to build, and was disassembled in the space of an hour and a half.

John Dykstra did most of the still photography of the model for the front projection plates. “The biggest problem with the still photography was that I couldn’t hold depth of field on a 4×5 plate over the entire length of the twenty-six foot model. So I shot photographs from three different focal positions, and then composited them by cutting out the sharp portions on each and pasting them together as a still. That was the only way we could keep it in focus over the entire length. Then we rephotographed them and added stars for the front projection plates. Incidentally, the two other ships in the film never really existed. They were simply photographs taken off of the *Valley Forge* miniature, and then composited as stills.”



The completed Valley Forge miniature, lit for a still plate photo session, on the stage at Trumbull Production in Canoga Park. John Dykstra photographed the numerous 4×5 plates required for front projection during later model photography and during the Van Nuys hangar shoot. Lighting the twenty-six-foot-long ship proved arduous since the domes reflected back all light source, along with cameras and any other photographic gear within range. To help alleviate the problem, the entire stage— floor to ceiling — was painted black.

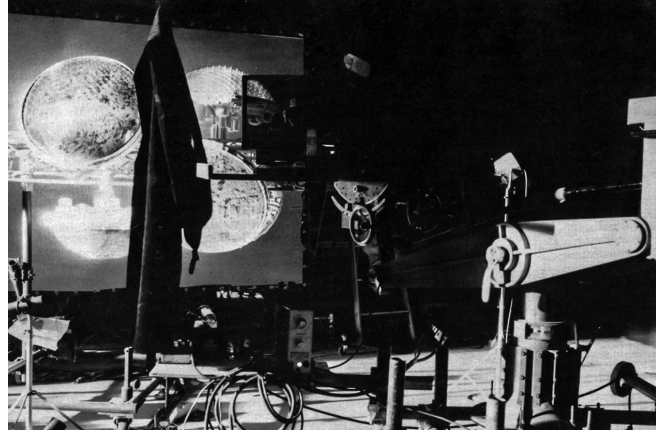
Another major project during preproduction was the development of the drones. The inspiration for the little robots had come many years before *Silent Running*, from a character played by circus performer Johnny Eck in the 1932 Tod Browning film, *Freaks*. The film portrayed, in poignant and sympathetic terms, the rather grim lives of circus freaks; and although critically acclaimed, it tended to offend public sensibilities and hence did rather poorly at the boxoffice. Trumbull, however, was impressed with *Freaks*, and was particularly fascinated by Johnny Eck — a bilateral amputee who could walk, run and even climb stairs on his hands.

“The little guy in the tuxedo who had no legs was one of the neatest characters I’d ever seen in a movie. And it occurred to me a long time before I made *Silent Running*, that if you took someone like that and put him in a robot suit, you would really defy an audience’s imagination as to how it was done. Most people simply don’t think people like that even exist. So that’s what I wanted to do with *Silent Running*. There was sort of a psychological rejection of the whole idea from the studio, though. They just couldn’t grapple with the concept of working with amputees. They looked upon it as unpleasant, and tried to talk us into using midgets — somehow midgets were acceptable. But we just insisted that we were going to do it our way; and because of the nature of our relationship with the studio, they didn’t have any way to stop us.

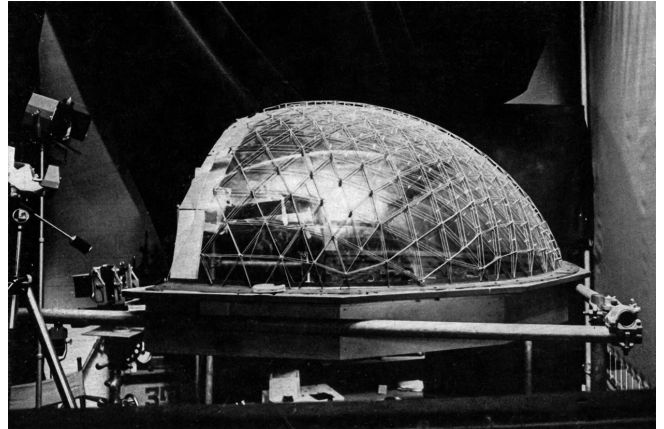
“The drones had really been the germ of the idea for the picture, and the whole movie was designed around the relationship between the man and the drones. Because of that, I went to extreme lengths to deanthropomorphize them, so that there were no eyes, nose, face, head — *anything* that you could recognize — and yet make them evoke a humane response. I think that one of the most interesting things that happens between men and machines, or men and animals, is that men try to anthropomorphize things around them — to make them tangible, or acceptable, or understandable. In fact, people often seem to imbue a lot more of their emotions into their dogs and cats than they do into their children. A lot of the relationship between Lowell and the drones is identical to that of a cranky old man in the wilderness and some huskies — it’s what a human being does to keep from being lonely. So we did everything we could to get rid of the concept of having a head and shoulders. In fact, we tried to make it look more like a little refrigerator than anything that was anthropomorphic at all.

“My first thought for casting the drones was that there would be quite a few of these people being cranked out from Vietnam. So we contacted the Veterans Administration, and I had my first, most difficult, interview at the VA Hospital with one guy who was a bilateral amputee. And I got my first initiation into what Vietnam had really done to people. For one thing, I found that bilateral amputees — particularly war veterans — are generally thrown into the geriatric clinics, because when a man loses both of his legs, more often than not he becomes a severe psychological washout. But I think the real story was that they just give up on them too soon. Anyway, we pursued that for a while, and even employed two guys we talked to — Leland McLemore and George McCart — both of whom were Vietnam veterans. Ultimately, they ended up not being in the film, but they stayed on and worked for us as model builders. Finally we came in contact with Rancho Los Amigos Hospital in Downey, which handles people who are born without legs or have some other deformity — people who have lived with it all their lives and have developed a hell of a lot more shoulder and arm musculature. As a result, they’re stronger and much more psychologically adapted to that

situation. Those who actually ended up being the drones in the film were all young kids. They all made good money, and bought cars, and just had the time of their lives.”



To avoid going through opticals for the insertion of appropriate backgrounds, the lightweight front projection unit was mounted on a boom arm and a Scotchlite screen was positioned behind the miniature. Still plates of stars, Saturn or nearby sister ships could then be composited with the Valley Forge in one pass on original negative. Since the model was too unwieldy to move, its motion through space was suggested either by shifting the front projection plate during the shot, or by moving the camera incrementally down a twelve-foot track.



The ship had to be meticulously lit to avoid dome reflections, particularly during the moving camera shots.

With the exception of one, who was in his early twenties, the young people selected to play the drones were all in their late teens. Jim Dow, who with Paul Kraus was responsible for the design and construction of the robot outfits, worked closely with all four. "Larry Whisenhunt had been born without anything from his pelvis down; I don't believe he even had a pelvis. Mark Persons had legs, but they were the legs of a four year old; so they were useless and were just kind of strapped underneath him. Cheryl Sparks had been born with stumps down to the knee. And Steve Brown had had his legs amputated jumping on a freight train when he was younger. But I think the kid that was the best was Mark — he was the blue drone. Whenever you saw the blue drone walking, that was Mark. He was our number one, star drone. He could do anything."

Bruce Dern found the actors' presence inside the drones to be extremely beneficial to his performance. "At First I felt so incredibly sorry for them, and that helped me in the scenes where I had to be sad in relating to them. But if we got that way, they'd just kick us in the ass because they were so thrilled to be alive and going on. So I got over that right away. I just decided I was going to treat them like any other fourteen-year-old kid. So we had a great comraderie which was really terrific. And for me, it was a big help to have them in the box. Because they were minors, we had rules that they could only work for four hours a day; but there were days when I insisted that we keep them there so I could have their presence in that little box. Somebody could move the box with a hanger, but it wasn't the same."

Dow and Kraus started with Trumbull's basic concept and developed the design for the drones. "Doug was always there, and he was invaluable as far as input was concerned," Dow remembered. But it wasn't as though he had to have everything his own way. He gave us total freedom to just go crazy and have fun with it. We would come up with several things, and he would select what he liked. Getting down to the end of the show, though, there wasn't time to come up with several



For greater detail, an eight-foot-diameter dome was constructed for use in shooting the 4x5 still transparencies needed for front projection plates in the forest scenes.



Inside the enlarged dome.

items. But by then he'd grown to trust us, so we'd just come up with something, and he didn't have to pass on it.

"Designing the drones was very much similar to the way you would do a prototype of a car or a plant of some sort. Many sketches were made, and then we began mocking up the first robot. From the first mock-up, we started building wood patterns for vacuum-forming. Because we were only making three units and enough extra shells for backups, we didn't have to go to an aluminum or more exotic pattern; so we just made them out of plywood. Then we sent those patterns out and had them vacuum-formed in Kydex, a very tough type of styrene plastic. After that, it was merely a matter of assembling and detailing. We vacuum-formed some of the small detail pieces on our platen. As far as the rest of the detailing was concerned, a lot of it was just surplus stuff — hoses and driving lamps and things like that — that we found in auto supply stores and junkyards. Each drone had two side shoulder pieces, two bottom pieces, a top piece, a front and a back. The arm pieces had quick-release fasteners. Then the pan at the bottom had a fabric web-built harness structure that went up and over the shoulders. Actually, we needed two slightly different designs. Cheryl and Steve were longer, so their pan had to be extended; Mark and Larry just had a two-inch pan at the bottom. The harness held the pan on; and ultimately, when this was all snapped together, it held the whole thing, bearing the weight on the shoulders. It was a real engineering feat to make these things so the kids could get in and out of them rapidly. We would take the arm pieces off first, and they would pull their arms in. Then the upper unit would come off.

"All the little mechanical things operated externally. The kids weren't able to operate anything from inside. There was no way they could have, except with their mouths. So all they had to do was walk and move. Even at that, though, the uniforms were very uncomfortable. For one thing, they were very warm. At one point, we were going to pump cool water through them; and then we were researching tiny little air conditioning units or fans. But the drone units were already so heavy that we didn't want to add any more weight to them. We did make the face plates removable though, so they could at least have air between takes, but they were still pretty claustrophobic. The kids could only stand to be inside for ten or fifteen minutes. And we never left them alone. We always had somebody standing by, because we were always worried about them falling over on their backs and then not being able to right themselves."

Each drone was equipped with a single "arm" which could perform such varied functions as playing cards, watering a tree and performing surgery. For the design and construction of these, Trumbull brought in his father, Don Trumbull, who had started out in film effects back in the mid-Thirties, but had later switched over to industry, working as an engineer for Lockheed.

"I must have worked on those for three or four months," the elder Trumbull recalled. "Time and equipment were scarce, and I did the best I could with just a little lathe and a drill press. I developed a pneumatic control system to operate them from remote with an umbilical cord. There were about twenty fine tubes in a bundle that came from the back of the drone, out of sight, to a control box that I had fixed up with all the levers necessary to cycle the air cylinders. We used dive tanks as the air supply, so that everything would be as quiet as possible.

"Doug wanted as many movements as possible out of it. Just like an arm, it could wrap clear up; and it could go sideways, and extend, then position. The wrist could rotate 180 degrees. And it could

clamp. There were at least sixteen to twenty moves in all. Then we had several different hand pieces — one that could hold a book, and then those for surgery. I also had one that would hold a billiard ball and one that would shoot pool, but those weren't used. The hand pieces could come out so we could change them. We originally set the arms up to be radio-controlled. But when we got them down on the aircraft carrier, with all the steel walls, the radio just didn't work. So, over a weekend, we rebuilt the thing so that it would work with an umbilical cord. Richie Helmer helped me with that. I didn't sleep all weekend.

"We also had to build some lightweight, nonfunctional plastic arms for the drones, for the sake of the amputees. With the working arm on it, they couldn't stand up and walk very well — the unit was front-heavy. So whenever the arm worked, we didn't have them trying to move around. In fact, when we were shooting the drones with the arm movement, often there were just weights inside — something to hold it solid. In the scene where they were playing cards, though, there was somebody in there — they had to cock a little bit to position properly — but they were still basically stationary."

Together, father and son developed the pool playing machine in the film, with the younger designing it and the elder engineering the pneumatic control. "I designed it as a modification from an existing machine," Doug Trumbull said. "That was an actual industrial robot, made by AMF, called the Versatran — a preprogrammable robot that they used on production lines to deal with difficult parts or dangerous situations. I had seen them before, and I wanted one for the pool playing machine. We had an AMF engineer who helped us program it to shoot the balls properly and do everything that we wanted. In fact, there was a whole sequence designed in the film that didn't get shot, where the drones played pool against the machine. It was a really funny sequence — one of my favorite scenes — but we just ran out of time and never could film it."

The drones — christened Huey, Dewey and Louie in the film — achieved the effect that Trumbull wanted, and were generally a smashing success. They have been called the predecessors of R2-D2 and the other "cute" robots which have invaded so many science fiction films today. "The funny thing about the drones," Richard Alexander reflected, "is that they were very different from what anybody else had done back then. When you really thought about it, though, they weren't very



One of the most inventive elements in Silent Running was the design of the drone robots — Huey, Dewey and Louie — which played pivotal roles in the picture's plot development. It was Trumbull's desire to achieve a total deanthropomorphized look — one that would not betray the fact that human beings were inside. To achieve this goal, he hired four young people — all bilateral amputees who could walk on their hands — to play the personable trio.

practical. You couldn't really run a spaceship with something like that. But they were kind of cute — everybody liked them.”

With only four weeks of preproduction time remaining, the *Silent Running* crew was faced with yet another undertaking — that of creating three vehicles for use on the hangar deck of the aircraft carrier. Bill Shourt and Gary Richards were assigned to the task. “In the film, the cars were supposed to be used as tugs,” Shourt elaborated, “and there was an outside design outfit that was going to make them. But they didn't do anything; so about a month before we were supposed to start shooting with them, Doug asked Gary Richards and me to build them from scratch. The design wasn't really spelled out, other than that it was a small, tractor-like vehicle, and supposed to not look like anything that existed. Gary did the design for the bodies, and then he and I built the molds to have them vacuum-formed. It was basically an unstable design, because it was four feet long and three feet wide — almost wider than it was long. And when you have anything that approaches being square, it doesn't know which way to go, so it was basically very unsafe. The bodies were vacuum-formed ABS, with a steel frame. The seat was something like a plywood bucket that held it to the frame, and then the body piece was bolted onto that.

“The cars were powered by a small, five-horsepower tractor engine, with a Salzburg torque converter and a centrifugal clutch with a variable drive transmission. There were just a couple of levers in front that controlled the steering and brakes. We didn't want to have anything like a steering wheel in them; and besides, they were so small that there wouldn't have been room — your feet were actually hanging over the front axle. There was a disc brake on the back axle, and a motorcycle throttle on the one hand; then there was a series of bell cranks, and all of this was connected together on a push-pull sort of thing. You would make a right turn by leaning into it, and pulling back on the right lever and forward on the left. Also, holding onto those levers was what held you in the car.”

To reduce the likelihood of breakdowns during filming, it was decided that the prototype vehicles — dubbed “Out-a-Sightos” by the effects crew — should undergo strenuous road-testing prior to principal photography. Volunteers were abundant. “Originally, the parameter was to have them go about fifteen miles an hour,” Shourt recalled. “Paul Kraus took one out and had it going about thirty-five or forty. Eventually we got it so that on a good surface, it was fairly safe at about thirty; but when you started trying to make it perform, it got pretty weird. The very first time I tested the vehicle, it didn't even have a proper seat in it or anything; I was just going to see if the steering geometry was anywhere near close. And what happened was that one of the drive pins had snapped, and the throttle stuck; so I couldn't steer it, and the thing would just do a wheelie and spin around in circles. Then it would drop down and go about twenty feet, and then do the same thing all over again. Meanwhile John Dykstra was chasing me around, trying to pull the spark plug wire off.”

Although it hadn't been his intention, Bill Shourt ended up doing some of the stunt driving in the film. “When we first got the cars down on the aircraft carrier, one of the actors — Ron Rifkin — got into one and tried to drive it. I don't know what happened, but I guess he freaked out and almost drove it out the side of the aircraft carrier. After that, he refused to even touch them any more, and so I drove for him. That's why, in the racing scene, you see one of the guys wearing a helmet — that was me.”

As preproduction time grew shorter, the *Silent Running* crew accelerated their activity, working twenty-four hours a day to stay within their tight schedule and impossible budget. As if the group did not have enough problems, nature decided to interrupt things. At six o'clock on the morning of February 9, 1971, the worst earthquake in Los Angeles history occurred. Measuring 6.5 on the Richter scale, it caused sixty-two deaths, over a thousand injuries, and property damage in the billions of dollars. Its epicenter was located only about seven miles from Trumbull Productions in Canoga Park.

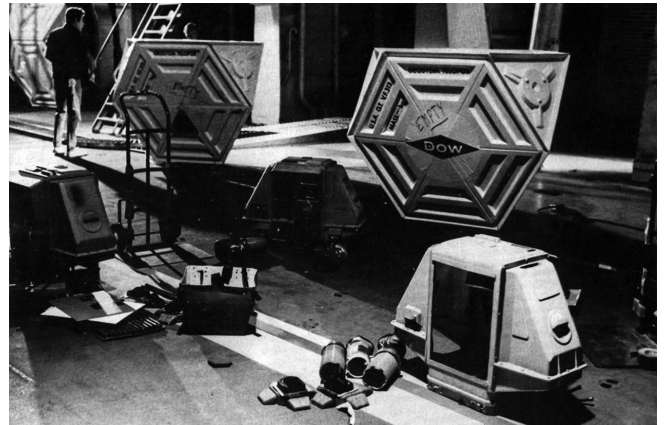
When the earthquake struck, John Dykstra and Gary Richards were in the shop, working on the model. "All of a sudden I heard this big rumbling noise," Dykstra recalled. "Then it started to shake. The lights went out and all the doors in the building began to rattle, and the last thing I saw in the fading light was big hunks of stuff falling. We had about thirty wall dividers, each about eight feet tall and four feet wide, and full of shelves loaded down with all kinds of stuff — and they all fell down. I figured it was the end for sure. I ran over towards the door — it was pitch black — and somehow I didn't run into a single piece of equipment. I got to the door and broke the locks to get it open."

Jim Dow was sleeping in his van in the parking lot at the time. "I woke up, and the car was bouncing around. At first I thought it was the guys jumping up and down on the bumpers. I looked outside and there was nobody there, but the red pickup truck we had was rolling past the window. It would crash into the gate and then it would roll back and crash into the building — back and forth across the lot. About that time, the big garage door flew open and John Dykstra and Gary Richards came running out and sat down in the middle of the parking lot."

Luckily, the effects facility survived without extensive damage. Very little detail had yet been applied to the model; and miraculously, the front projection unit had remained upright. "What's funny," remarked Dykstra, "is that we had the front projection machine — which had just been completed — sitting on three or four apple boxes, on rollers. And everything in the shop fell down, but somehow this \$40,000 piece of equipment, precariously perched on three or four apple boxes, didn't fall over. It just rolled back and forth."

In all, preproduction lasted for about six months. Trumbull, as director, found that he had too little time and opportunity to contribute to special effects on the same scale that he had done for previous films. Many of his working hours were devoted to such chores as selecting the cast. "Mike Gruskoff and I were looking for an actor to play Freeman Lowell. We had been screening a lot of films, and finally came upon a couple of things that Bruce Dern had done. I was immediately taken with him, because he had a terrific presence on the screen, and he had the right sort of offbeat face and voice for the role. The only other one we seriously considered was Gene Hackman — who was as available as Bruce at that time — but I somehow had a more immediate response to Bruce. We asked him to come in to Canoga Park — I think it sort of blew him out, to be asked to come to some warehouse to get an acting job. But he really got behind the project; and ultimately, I think it turned his career around. Before then, he had always been cast as a baby killer. I enjoyed working with Bruce tremendously because he had a great understanding of what I was after. The other three guys — Cliff Potts, Ron Rifkin and Jesse Vint — were younger and less experienced, and I don't think that they really put out. At the time, I didn't know anything about directing a picture or working with

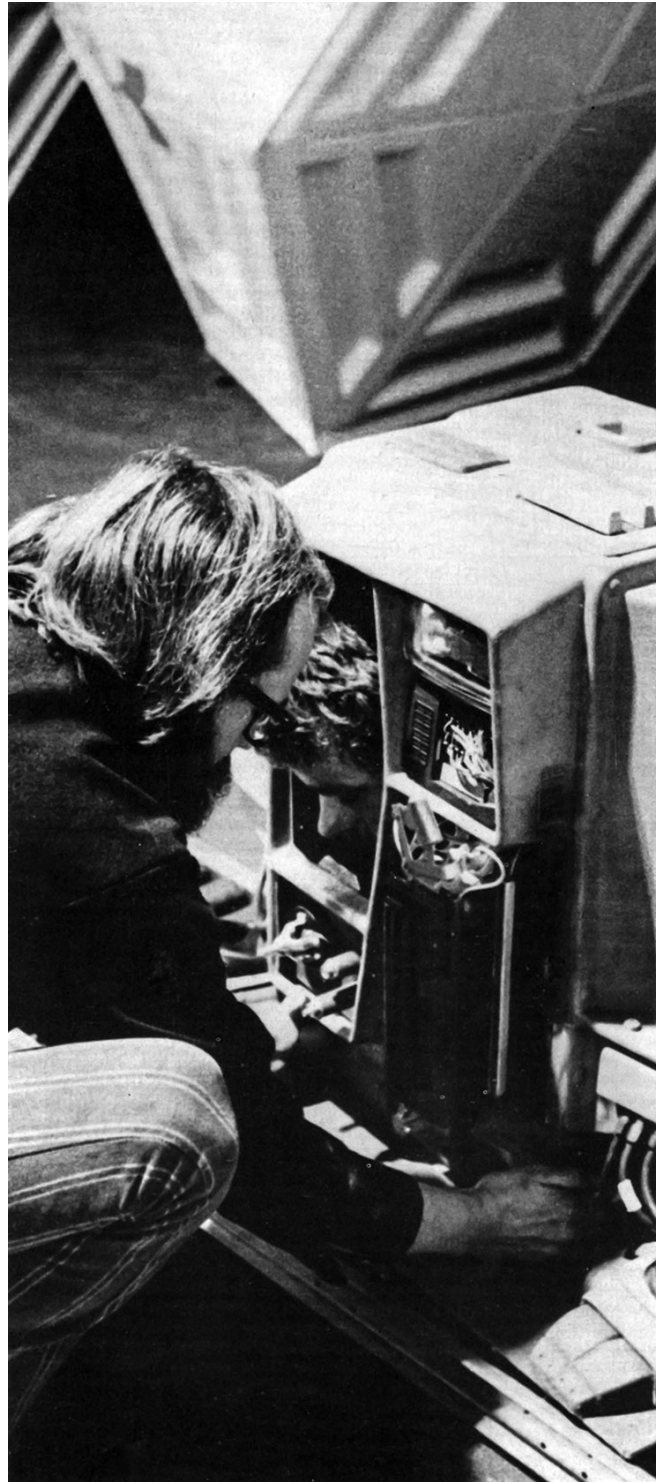
actors or describing to someone what emotion I wanted to see. That was very hard for me, and those three were very unhelpful. They felt that they were just working on a B-grade science fiction movie, and they didn't make any attempt to deliver."



Disassembled drones sit on the floor of the aircraft carrier's hangar deck. Each unit was designed in segments to facilitate quick and easy donning by the amputee actors.



Bruce Dern and Douglas Trumbull discuss a scene with drone actor Mark Persons.

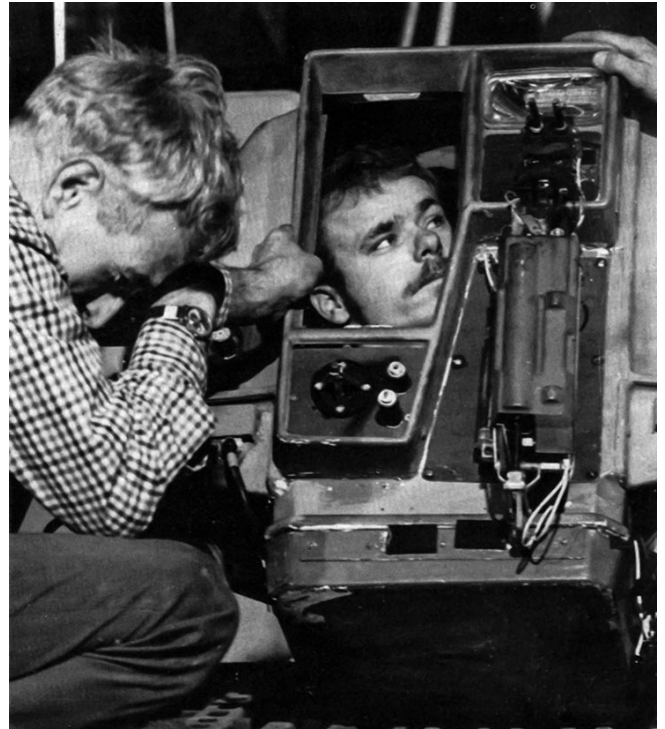


With faceplate removed, Persons observes as James Dow makes adjustments on the drone unit for a scene in the cargo hold. Dow, along with Paul Kraus, was largely responsible for the design and construction of the drones.

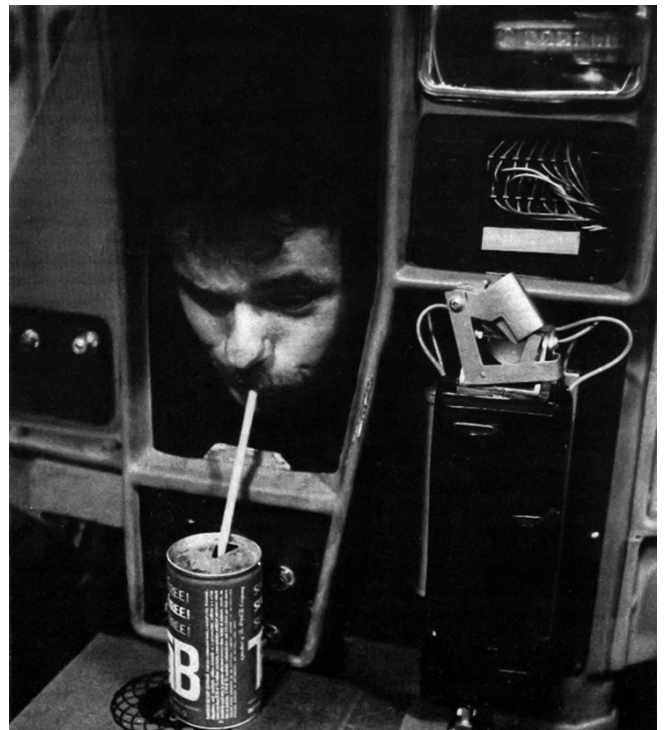
Because of the tight budget for *Silent Running*, its principal shooting schedule was necessarily short. The entire film, in fact, was shot in thirty-seven days, with about two weeks spent at the Van Nuys airport and twenty-five days on the aircraft carrier. Working on the Navy ship presented some unique difficulties for director of photography Charles Wheeler, who referred to the experience as “making a space picture in no space.” Often quarters were so cramped that the camera operator could barely get his head between the camera and the wall. Then too, the many odd little cubbyholes and shadow areas presented a lighting dilemma, requiring more illumination than a less unusual set would have done. This problem was overcome by simply putting lights wherever they were needed, and making them look as though they were a part of the set rather than trying to conceal them. But even getting to that point was a major exercise in logistics. All the bulky camera and lighting equipment had to be carried up the ship’s gangway by hand, then transported across the hangar deck with hand trucks, and finally hoisted up ladders to the Combat Information Center. Even then, the equipment had to be maneuvered into position through narrow, low-ceiling corridors and hatchways. To facilitate getting the amputee drone performers up into the working set areas, chair elevators were installed from the ground to the hangar deck and then from the hangar deck up into the C1C.

It was only when principal photography commenced that union personnel became involved. “We were trying to save money,” Wayne Smith revealed, “so the initial crew were all just people we knew. None of us were union. The effects and the preproduction were both nonunion; but when the main part of the film started, the shooting crew had to be union people. They mixed a couple of areas where our nonunion group had a certain expertise — we just got a waiver. It was fairly straightforward.”

“We got away with quite a bit, in terms of the unions,” Trumbull affirmed. “We got a tremendous



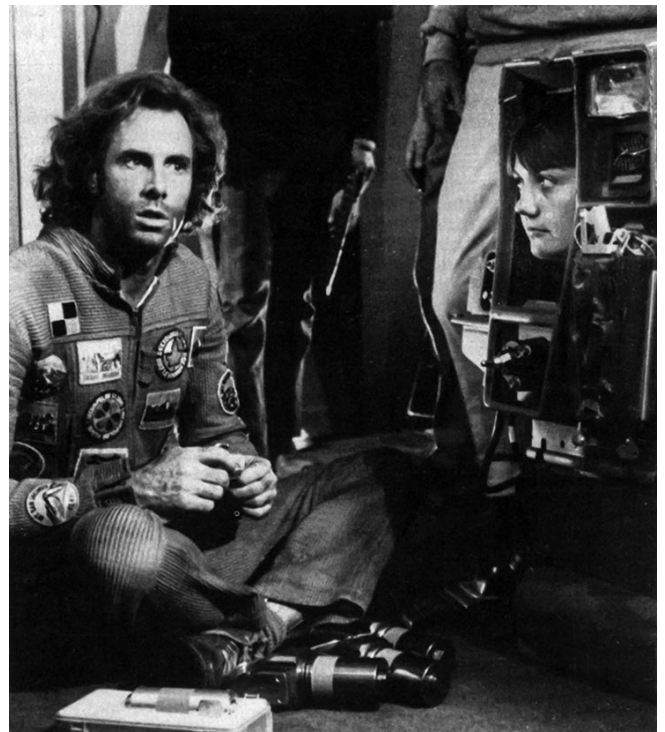
Effects technician James Rugg jockey's Mark Person's drone into position for a scene on the outer hull of the Valley Forge.



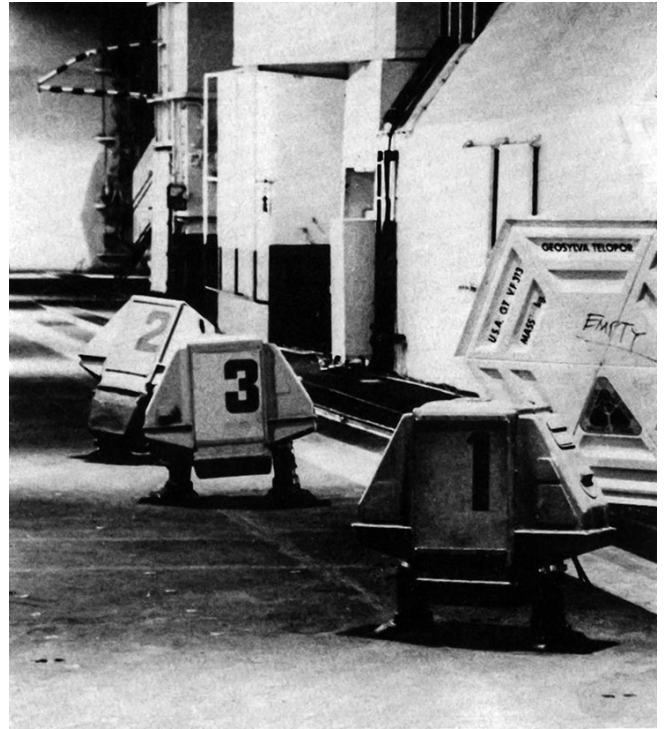
Between takes, Persons takes a soft drink break. Generally, the drone actors could only stand to be inside the overheating, claustrophobic suits for ten or fifteen minutes at a time.

amount of flexibility, from Universal as well as the unions, to allow us to construct sets ourselves and build miniatures ourselves, and to shoot under very controlled situations without getting into huge expenditures.”

When the shooting started, Universal was obligated to assign a union special effects man to the film. The individual assigned was James Rugg, who became a valuable asset, primarily responsible for operation of the pneumatic drone arms. The original special effects unit, in the meantime, was continuing work independently at Trumbull Productions. “There was a live-action union crew going at the same time the special effects were being done with a nonunion crew,” said Dykstra, “simply because there was nobody in the union at that point who was qualified to do some of the special effects that we were doing. It was one of the first combination nonunion/union productions, and that was a real groundbreaker.”



Cheryl Sparks peers out of her open faceplate as Bruce Dern prepares for the final scene aboard the Valley Forge.



Huey, Dewey and Louie supervise the conveyance of equipment modules within the ship's cargo hold.

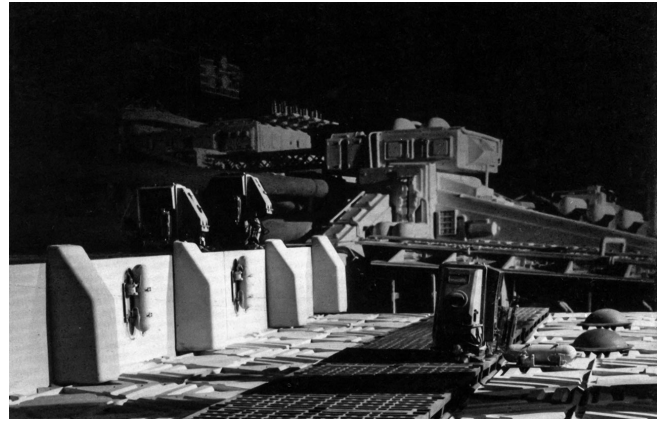


Douglas Trumbull directs Huey and Dewey in a scene staged inside Freeman Lowell's sleeping compartment.

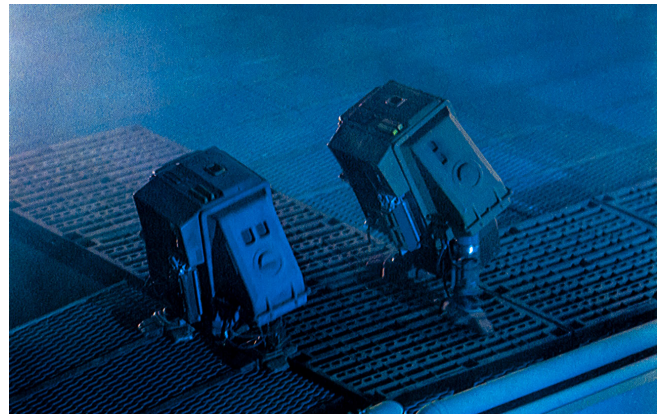
Effects work continued in Canoga Park for about six months after the live-action shooting was completed. John Dykstra was kept busy photographing the miniature *Valley Forge*. “It might take me six or seven hours, or longer, to set up a shot — and those were pretty simple shots by today’s standards. One of the worst problems was photographing the domes. Those domes were fish-eyes; they were 180-degree field lenses, really, because they were polished plexiglass hemispheres. So when you put the camera up close, you saw every light source in the room, as well as gobos, camera, dolly, track — everything. Our solution was to paint the entire stage black, including the ceiling, walls and floor. Hiding the lights that illuminated the domes was another real nightmare. The domes had to be lit from the outside, and anyplace you’d put the light — except one very small, exact angle — would be reflected in the camera. And then, of course, there were always camera moves, so you had to hide the light during the entire shot. As a result, we had lots of little pieces of rope tied to the camera that went up and over a pole, and came down attached to pieces of black velvet. Then, as the camera moved forward, it would lower the velvet over the lights so they wouldn’t be reflected on film.

“Once I finally got a shot set up, then I’d have to shoot it at f/22 or smaller in order to hold depth of field. So the exposures were astronomically long — sometimes as long as thirty seconds per frame. The camera was mounted on a twelve-foot dolly track, and since the track speed had to relate to the camera speed, we had to move the camera past the model at speeds as slow as an inch a minute. I did about twenty-five or thirty of those tracking shots. And there were a lot of long hours spent, because I would do the lighting, and move the track, and move the camera on the track; and then I would put the plate in and cut it out, and sometimes I shot the plate. Then I went around and moved all the lights again and set all the gobos. I sat in there for hours at a time, grinding out shots on the big ship.

“We used front projection to provide the backgrounds of the stars, the other ships and Saturn. The camera was mounted on a front projection rig, and what we did was move the projector and the camera relative to the miniature of the *Valley Forge*, which had a front projection screen positioned behind it. The background — which was, of course, in the projector at that point — was locked off to the camera. So it made it look as though the ship was traveling through space. We also had the



The three drones perform maintenance on the outer hull. A full-size, though partial, section of the ship’s exterior was positioned in front of a Scotchlite screen on which was front-projected composite still photographs of the rest of the ship, taken from the miniature. (The background image appears dim because the still photograph was taken at a slight angle to the projected image rather than dead on as required for proper light balance.)



Huey and Dewey make their way to safety as the Valley Forge plunges perilously through the rings of Saturn.

ability to move the background plate, to make it appear as though the camera were moving.” Background plate movement was effected through the use of an electronic panel Doug Trumbull had devised which could be programmed to accomplish the minute movements at whatever speeds were desired. “The front projector had a 5×7 photographic area,” Dykstra added, “of which only 4×5 inches would actually be projected. As a result, you could move the plate background up and down and side to side, and rotate it if you wanted to.”



Huey and Dewey attempt — with little success — to aid Lowell in planting seedlings. The two robots were configured somewhat differently to accommodate the physical differences of the performers inside.



Don Trumbull and assistant Richie Helmer operate one of the mechanical arms built onto the front face of each unit. The pneumatic control system devised by Trumbull allowed the arms to be activated remotely through an umbilical cord.

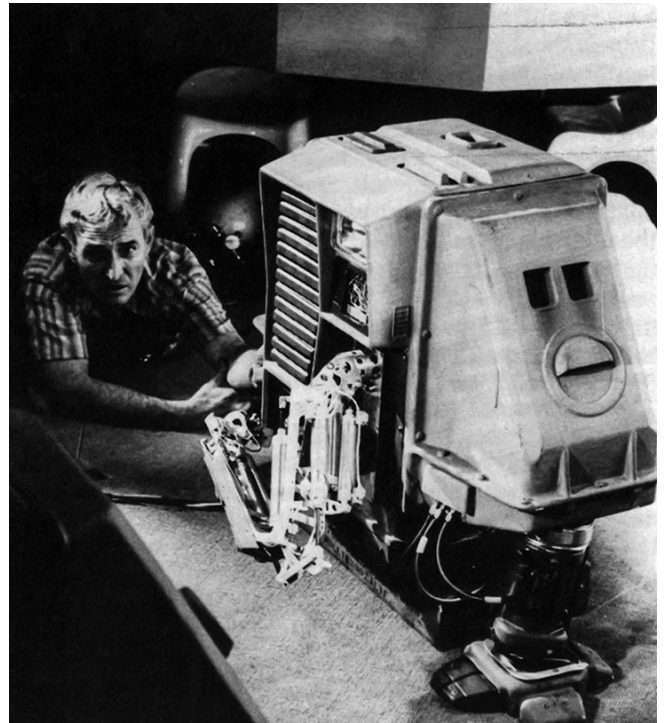


Interchangeable hand pieces allowed for the holding of such diverse objects as playing cards, surgical instruments and billiard balls.

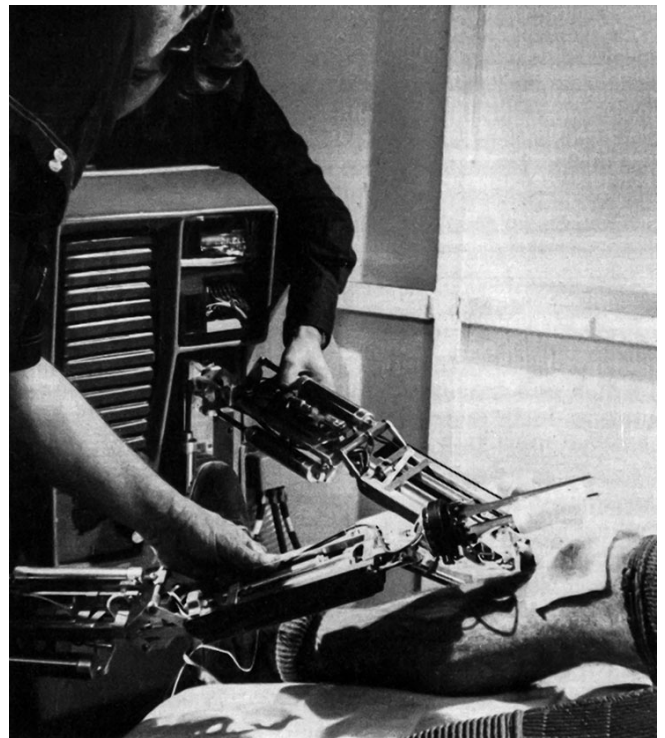
“Using front projection with the model was somewhat difficult,” Richard Alexander interjected. “The ship was a spider-web of framework — something like a honeycomb — and to cover the support, we had to have little pieces of front projection material stuck in all kinds of weird places. Invariably we would forget to put one little piece in somewhere, and there would be a big black hole so we’d have to go back and reshoot. Then, too, we were constantly crashing the camera/front projection unit into the model. It had funny little electric motors on it; and someone would invariably turn the switch the wrong way, and it would plow into the model. The control of the camera motion was very human — it was manually put in, by cranking knobs and watching markers on the tracks.”

During principal photography, John Dykstra was required to work nights in order to free the front projection unit for the interior dome sequences that were being filmed during the day. After shooting with it all night at the shop in Canoga Park, he would personally lug the machine over to the airplane hangar in Van Nuys at seven a.m. for an eight o’clock call.

Richard Yuricich was responsible for the shots of the *Valley Forge* where movement could be suggested without the need for perspective changes on the model. “After the live-action photography on the aircraft carrier was completed, I got a call from Douglas to come and work on the effects photography. So I left the production I had been working on two weeks early, and joined him. When I showed up at Trumbull Productions, there were forty-five effects shots to do to complete the film, with exactly forty working days left. Normally, we would have photographed the miniature, gotten a print back, struck an interpositive or separations, and then matted it into stars or whatever else was in the film. But we were pressed for time; so after looking at the shots, I suggested to Douglas that we just shoot some of them using still photos on an animation stand. He immediately carried that suggestion two or three steps further — as he usually does — and he and Colin Cantwell spent an afternoon on the floor with scissors, dreaming



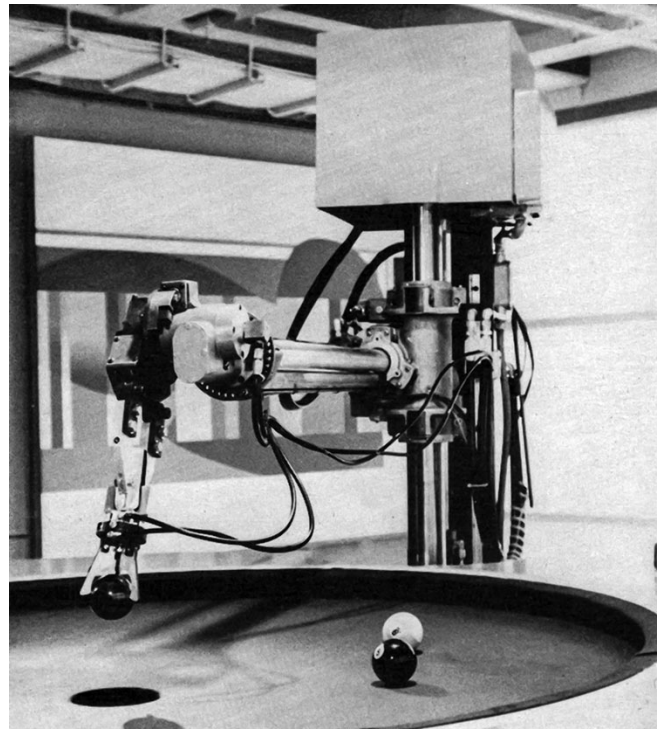
James Rugg activates one of the arm mechanisms.



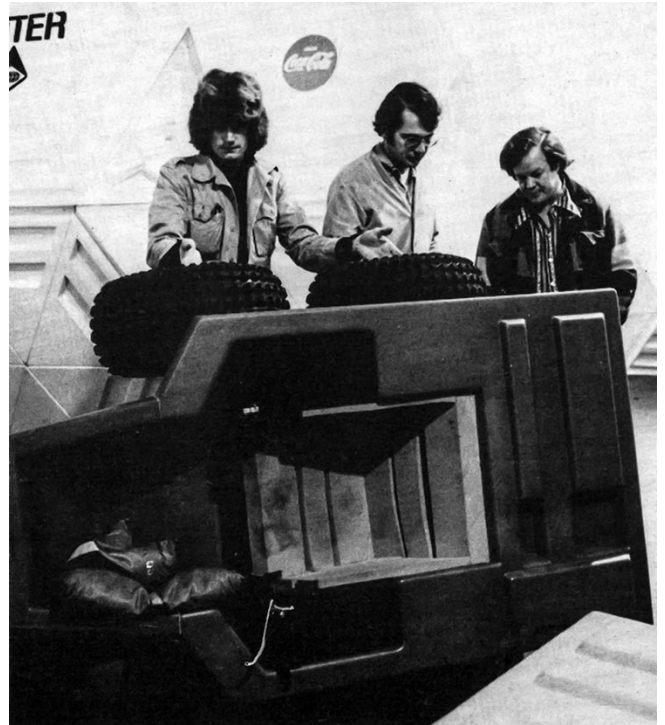
Don Trumbull and Richie Helmer prepare for the sequence in which the drones tend to Lowell’s injured leg.

up which way the shots would go and cutting up the storyboard to rearrange them into an animation stand concept. We changed maybe twenty-six of the shots off the board to animation stand shots, using 8×10 and 11×14 blowups. The blowups were high-quality stills that had been originally destined to end up on somebody's wall; but they happened to be at the shop, so we used them. They'd been done with a large format two-and-a-quarter camera, so the quality was good. We ended up cutting them up, or using them as they were, and putting them on black pieces of paper we could use on the animation stand. That weekend, I went into town, rented an animation stand, and went to work.

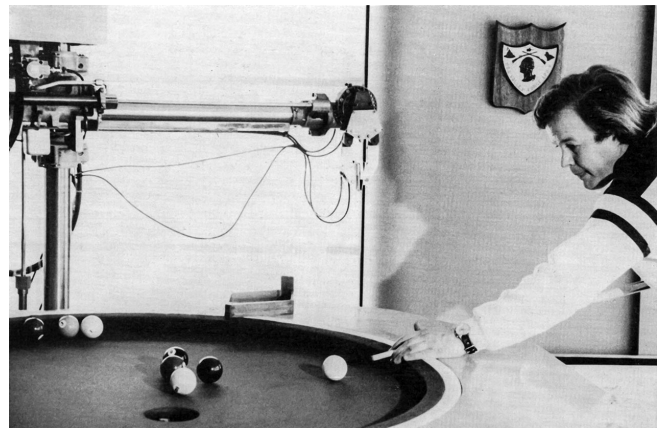
Some of the prints were overexposed, and would have duped strangely with the normal polarized lights on the stand. To correct the prints, I pulled the polaroids off the lamps, and then I turned one lamp off and just lit it from one side. I had gobos and flags and tape running all over the room, adding shadows and things — it was the funniest setup you ever saw. The stars were just white speckles of paint airbrushed onto black animation paper; and they were done on a separate pass using a black cutout of the ship as a matte. The reference for the *Valley Forge* movement was against either static stars or moving stars. Lots of times we moved the stars right to left, to make the ship look like it was going left to right; other times, the stars would be static, and we would move the still photo of the ship across the screen — all depending on what was called for. When I added the stars, I had to remember to put the polaroids back on the lamps. I remember working on one shot that took maybe six or seven hours to get the first three passes done. Then I made a mistake and forgot to put polaroid on the last pass. It was perfect, except for the glare from the animation paper on the star pass.



An AMF Versatran industrial robot was modified into a programmable pool-playing machine for the recreation room.



Richard Alexander, Bill Shourt and Doug Trumbull examine the underside of one of the mini-vehicles designed and built for use in the cargo hold sequences. Intended originally for speeds in the range of fifteen miles per hour, the cars were often pushed to thirty-five or forty, which combined with their unstable configuration made driving them a somewhat hazardous challenge.



Between takes, Doug Trumbull tries his hand against the machine.

“The shots we were able to do that way were the long to medium shots. The closeups, obviously, had to be done on the miniature, because you could see the perspective changes. But when you’ve got a craft out at infinity, you can often get away with it. To this day, I imagine most people think those shots were miniatures, when in fact, they were nothing more than still photos, top-lit, on an animation stand. Anyway, I worked the whole weekend through, and on Monday all twenty-six shots were completed. Then I took the next week off.”



Bruce Dern at the controls.

Yurich’s involvement was by no means over, however. “I did some held-take photography on other shots — where the domes blasted away into space, for example. Most of that was done so we could put stars in on an animation stand and not go through the optical process. First, I would shoot a miniature in color, front-lit. The shots were basically stop-motion. We did them on a track, with a digital counter and selsyn motors and a follow-focus system that kept everything sharp. Since the moves were so slow, the stop-motion worked fine. Then I would dress the miniature up white and shoot it again — also stop-motion — pulling a black-and-white matte. We’d take that film — the one of the matte — process it, and get a black-and-white print, which we would then put in bi-pack with the original, unprocessed color negative. Both had a common sync mark that was predetermined before shooting, and I did that simply by punching a hole right in the center of the frame. Then, by running the color negative and the matte together, we could put the stars in on the animation stand.”

The held-take method was not without its difficulties, however. “We had to generate as many held takes as we figured we needed to complete the shot,” John Dykstra explained. “So if there were six elements, generally we would have to develop one each take — which meant that we would usually shoot eight takes. For the first pass, that wasn’t too bad. We just had to do it eight times. But then, it’s seven times the first and second; and six times the first, second, and third; and so on. And invariably, somebody would walk in on a shot. With thirty-second exposure times, we’d get material back and there’d be this blur across one frame where somebody walked through the shot. Of course, nobody would say it was them. Or someone would come in and have a cup of coffee and a cigarette in the corner — and you’d see them in the shot, because they were standing there still, watching the camera run. You’d just want to kill them.”

By employing front-projected backgrounds, animation stand composites and bi-packed held-take photography, the *Silent Running* effects unit was able to keep traditional film opticals to a bare minimum. As a result, the optical bill was reduced to a miniscule \$18,000 — much of which went toward simply adding the titles — and the film, for the most part, maintained a clean, first-generation look.

One series of shots which required rather complicated effects was the separation of the domes from the ship. “Those were simulated after actual separation maneuvers that I had seen shot from cameras on board spacecraft,” Trumbull explained. “And for those we used large model pieces. The

collar that connected the domes to the ship on the actual twenty-five-foot model was only about two-and-a-half inches in diameter. Since that was too small for the closeups, we built a six-foot long, double-overlapping connecting collar — with blow-apart panels that were about nine inches in diameter — and mounted a camera inside. We made little cavities, with air jets, and we'd fill them full of mica and broken pieces of plastic and blow the thing apart. We filmed it at about 120 frames a second, shooting straight up so that the stuff that was coming apart would fly out in all directions or fall toward the camera. We took many, many takes getting that effect."

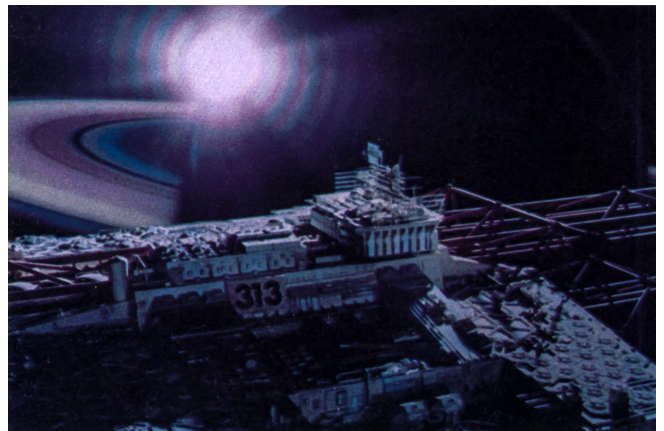
Richard Alexander was responsible for creating the model for the sequence. "It was kind of a clam arrangement — six little arms, three from each end, which we clamped together. It had big pneumatic cylinders inside, and there were two valves in each end — one for opening, and one for closing. We filled little trap doors with plastic chips and little pieces of soldiers' bodies and things that we fished out of the Japanese model kits. The whole thing was on a small track, and when we hit the button, it pulled away for about three feet and just exploded — and everything sort of showered down."

John Dykstra supervised the high-speed shooting of the dome separation. "We had the film editor, and the assistant editor, and everybody else out there for this one shot. There were seven operations that had to take place, and everybody had a button or a switch or a lever or dropped something; and they all had numbers. So the camera was rolling, and I was lying on the floor shouting: 'One! Two! Three!' I remember the editor standing there with fifty pounds of lead. When he let go of that weight, the collar pulled apart. So it was a true human-cybernetic venture; but that was some of the most effective stuff that we did. That shot has been duplicated a million times since then."

To complete the sequence, the held-take photography that Yuricich had shot of the dome miniature was added, combined with engine exhaust which was created and photographed by Doug Trumbull. "We had a domed surface that was about two feet across — just slightly convex. It was absolutely smooth and glossy black, with a little hole in the center. And we had a small pump that would bring water up through the center that would spill down across the dome in an absolutely even sheet. Then we injected milk into the system — it was a readily available white substance — and it would spill out around the edge of the dome in the same manner. We were shooting straight down — like an animation stand — at high speed, and we had it lit so that it was very bright in the center and very dim around the edges. What we got from that was a process plate of this sort of vaporous-looking white stuff emanating from the center. We projected that up on a white card and rephotographed it, added a bright light in the center for a lens flare, and ran the whole thing down the track for a rocket flame effect."



The Saturn background still plates were created using streak photography. Colored artwork was first projected onto a large semicircular surface, rotated 180 degrees while the camera shutter was open to produce a swirling sphere of color. A flat panel was rotated and photographed in the same manner to produce the planar rings. The two images were then pieced together, retouched slightly with an airbrush, and combined with a star background.



The Valley Forge emerges from the dark side of Saturn.

Another special effect, although few would have guessed it, was the image of Saturn included in many of the front projection plates. Surprisingly, this was not a painting but rather a 4x5 transparency created through streak photography. “I worked with Bruce Logan on that,” Dykstra recalled, “before I got into shooting the still work. We used a variation of the Jupiter machine that was made for 2001 — basically a white ring with color slides projected onto the edges. The machine we used was taller than the ceiling and used an arc with a six-foot radius. Then that whole rig rotated, which created a circular streak that looked like Saturn — old hat, now. We probably could have created the same result with an airbrush painting, but to do that you’ve got to have somebody like Don Moore, who’s really good. Besides, with the Jupiter machine, you get some diaphanous color changes that are neat, especially when you rotate the image in the projector while you’re doing the smear. It gives you subtle gradations that change as you go all the way around the surface. Also, you create an enormous piece of original photography, rather than having to work from a tiny piece of artwork.”

One of the most impressive sequences in *Silent Running* was the journey of the *Valley Forge* through Saturn’s rings which, like the Jupiter machine, was an application of Trumbull’s experience with Kubrick. “It was a very simple extrapolation of a test that I had done on 2001. Basically, it was slitscan — bouncing light off a drum covered with bent mylar and shooting it at different angles to match the angles of the spacecraft. We opticalled those two things together in a very simple double exposure, and then rear-projected that at speed onto a three-foot-wide rear projection screen. Then I rephotographed it with a hand-held camera to interject a lot of camera shake — which was one of the things that made the whole sequence hold together. Optical shots and effects shots are usually locked off, and it makes people very uncomfortable. Besides, we figured the camera shake would obliterate whatever grain and contrast buildup we were getting. We got a little carried away at one point, though, and in one of the cuts you can see the camera go right off the process screen for a few frames.”



The Saturn imagery was also front-projected into some of the live-action dome scenes shot at the Van Nuys airport.

The slitscan shots, which created the diaphanous effect of the rings themselves, were set up and photographed by Richard Yuricich. “We had a drum that was about six feet across, and a foot-and-a-half in diameter, put together by Bill Shourt and Dick Alexander. It was built on a pipe that was driven by a chain, that was driven by a selsyn motor, that was connected to the track. It was covered with crinkly reflective material, and there were colored gels on about five or six 2K lamps in the background. The colored reflections were bounced onto a screen, and we just shot them from there. It was pretty much like normal slitscan, except that we were just shooting the *reflections* of the drum, on a surface which was masked off by two pieces of velvet. The slit was about a half a foot — just the amount that the mask allowed us to see. The drum rotated in synchronization with the camera moving on the track from infinity to foreground, rotating away from the camera when the camera went in, so that the reflection gave the impression of coming towards you. Then the camera would come to a stop, and a relay would kick in with another motor that would advance the drum. It then rotated towards camera as the camera went out so that the direction of the reflection was always the same, but there was a different registration between each move.

“The process was really tedious and time-consuming. I would set up the shots and leave, and the machine would run all night long. Jim Dow was doing double duty. In addition to working on the film, he would sleep next to the machine at night; and the thing would set up this kind of rhythm — first you would hear the relays clicking over; then you would hear the camera run in; then the gears on the track, and the selsyn motors on the follow-focus and the drum. They were very distinctive sounds, and together they made a kind of music that Jim got so used to that if something went wrong, the silence would wake him up. He woke one night to a fire, and put it out and left me a note the next day to set the machine up again.”

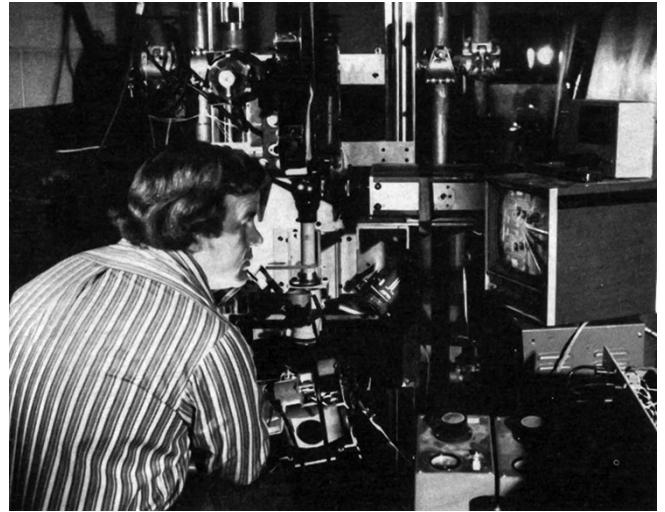
Far less complicated was creating the effects for the nuclear explosions of the domes. “That was just a little spotlight,” Trumbull revealed, “mounted behind a sheet of black paper with about a quarter-inch diameter hole in it. I had a variac on the light so I could vary its color temperature and brightness, and I shot the explosions at speed — twenty-four frames a second. I had a motorized zoom lens on the camera, and I found that by simultaneously zooming the lens, varying the brightness of the light, and throwing it in and out of focus, I could create these variable rings of bright, flaring, exploding appearance. It took about half an hour to shoot all of them.”

The final effects sequence in *Silent Running* is the scene in which Lowell, back in touch with civilization and in a futile situation, blasts the last remaining dome into space for safekeeping and then destroys both the *Valley Forge* and himself. “The final explosion in the film was a combination of effects,” Trumbull explained. “When he blows up the whole ship, there was an optical of the flare effect that I shot at speed, plus we dumped a whole load of model parts and mica at the camera — shot at highspeed, with the camera aimed straight up. Then we had a section of the antenna off the front of the ship, mounted on a rig that rotated very slowly and spun out of frame — that was shot stop-motion.”

Universal had allotted one million dollars for the making of *Silent Running*. At \$1.3 million, it ran slightly over the intended budget. However, reflecting on the lush appearance of the film and the special effects that were achieved, *Silent Running* was amazingly inexpensive, coming in at only slightly more than ten percent of what *2001* had cost several years earlier. One basis for the low price of the picture was that it was done independently of the studio, and therefore could legally utilize a small nonunion crew. Another was Trumbull's brainstorm of having someone at Universal contact various potential corporate sponsors and sell them on the idea of subsidizing the production. "We got quite a bit of help. The major amount was from Dow Chemical, who were in hot water at the time because they were supplying napalm to Vietnam and really wanted to help their public image in any way they could. We wanted to try this vacuum-forming thing, and found out that Dow Chemical was the major local supplier of styrene plastic. They were fantastically helpful to us, and supplied us with about \$60,000 worth of foam plastic and raw styrene that we could have injection molded or vacuum-formed.

"We had another terrific deal with Concord electronics, who supplied us with the four dozen or so video monitors that were seen in the control room of the spacecraft. It was a very simple and straightforward black-and-white closed-circuit system. We had eight video tape recorders running simultaneously to play the information into the monitors; and we had fabricated a lot of fake readouts — sort of the way we did on *2001*, but on a much lower scale. We never went to the trouble of trying to sync up the video signal to the camera because I liked the fact that there was a roll bar. It gave a little activity to the set even when things were out of focus and in the background.

"We also got a special deal on hundreds of plastic model kits from Japan; and American Airlines helped us procure some things at their expense. We



*For a video insert required during the sequence in which Lowell reprograms the maintenance drone's circuitry, Trumbull employed a microscope rig he had developed originally for the electron microscope simulations in *The Andromeda Strain*.*



Richard Alexander examines the oversize coupling section built for the scenes in which the forest domes are disconnected and jettisoned out into space. For the actual separation, a high-speed camera was mounted inside, shooting straight up so that the small interior cavities,

tried to give them all credit — both at the end of the picture, and by displaying their logos all over the film. Many of them were pasted on the cargo containers in the hold of the ship, and the Concord electronics logo showed up constantly in the closeups of the monitor screens. We put the American Airlines logo on the outside of the ship, and there was a little American Airlines armpatch on the astronauts' outfits."

For a reverse angle from Lowell's opening of the kitchen window, a highly-detailed four-by-six-foot mini-section of the Valley Forge exterior was constructed, with a sliding window to the left of the American flag and a small rear process screen behind it on which matching footage of Bruce Dern could be projected.

Trumbull also handed Universal a bargain by offering the services of Trumbull Productions on a no-profit basis. "I've always been very naive about making a profit. And during the time of the picture, I was convinced — as all movie makers are — that it was going to be a blockbuster and make a lot of money and that points with the studio would be very valuable. So my whole company operated at no profit for about a year — which ended up costing me a lot of money, because there were unforeseen expenses in taxes and so forth that we couldn't bill to the studio. The whole thing was a total wash — and it was one of the biggest mistakes I ever made."

All other things considered, for \$1.3 million, the quality of *Silent Running* could still not have been achieved without its crew of young, enthusiastic, highly imaginative craftsmen. "When you consider what we had to work with," Jim Dow reminisced, "that project was amazing. We were just a bunch of kids and it was all ours. I don't think I've had nearly as much fun since *Silent Running* — never since have I been given a United States Navy aircraft carrier to play with."

Dykstra, too, reflected upon that period as one of particular freedom and creative value. "We didn't make very much money; but it was a nice, loose environment. There were six of us working as the core group at the shop, and three of us lived there. It was a family organization in the sense that everybody wanted to to work on everything. We got a lot of experience; and that was really the start for me, in terms of doing special effects." Indeed, *Silent Running* was the springboard for several successful careers. Most of the crew went on in the fields of effects and design, finding their way into the credits of such notable effects-oriented productions as *Star Wars*, *Close Encounters of the Third Kind* and *Star Trek — The Motion Picture*.

In 1971, Douglas Trumbull — young, inexperienced, and largely unrecognized — had set out to make not only his first feature film, but also a definite statement. "My objective wasn't to make an extravagant special effects film at all. Everything we did was designed to be as simple and straightforward as possible, because we just had no budget to do anything in depth. My whole idea was just to do a story revolving around the drones and their relationship with Lowell. Many people who saw the film interpreted Lowell as a total maniac; but I didn't see him as a maniac at all. People in this culture — particularly men in this country — are so wrapped up in macho bullshit that nobody is willing to admit what they do when they're alone — simple day-to-day things like how they really talk to their dogs when no one else is around. I wanted to get into that, and I wanted to show a character with a conscience and a certain sense of morality. I've never seen a character like that before or since on film.

"I must take the ultimate responsibility, though, for letting the story get sidetracked into other realms that detracted from the real strength of the movie. I let myself spend precious shooting days

on fights between the guys, when I should have been shooting the pool game where Lowell is watching the drones play against the automatic pool machine — which was really more what the story was all about. *Silent Running* was a sort of reaction against all of the gross films I had seen over the years that always portrayed robots as malevolent, horrible killers. I've been very involved with machines and special effects and technology for a long time; and it bothers me that technology is so often considered to be inhumane and worthless. I have always had a warm regard for technology and its uses for art, and I wanted to say something about that. I wanted to show that, really, machines *do* things for people — they are what you want them to be. That was my whole objective.”

Pamela Duncan is a graduate student majoring in environmental politics at Colorado State University.

Silent Running photographs copyright © 1972 by Universal Pictures. All rights reserved. Special photographic contributions by Douglas Trumbull, Wayne Smith and James Dow.

